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Geology of

Harvey Township

Peterborough County

By

R.L. Morton

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Minister

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FOREWORD

HARVEY TOWNSHIP

The Harvey Township metavolcanics and metasediments contain occurrences of copper. Copper is also found in association with molybdenite in quartz monzonite and quartz diorite stocks. Two bands of iron formation and five known uranium deposits occur within the map area.

The aim of the detailed mapping in Harvey Township is to provide an effective base for determining the mineral and land use potential of the area. The study will provide geological information that will lead to a regional synthesis and interpretation of the geology of southeastern Ontario.

E.G. Pye
Director
Ontario Geological Survey

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GEOLOGICAL MAP

(back pocket)

Map 2475 (coloured)–Harvey Township, Peterborough County.

Scale 1:31 680 or 1 inch to ½ mile.

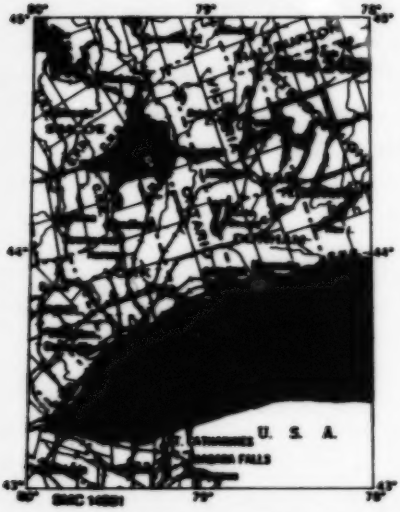

Figure 1–Key map showing location of Harvey Township.
Scale 1:3 169 000 (1 inch to 50 miles).

ABSTRACT

Precambrian rocks in Harvey Township lie in the southern part of the Grenville Structural Province. The centre of the area is located at about 78°20′W Longitude and 44°35′N Latitude. All Precambrian rock units have been regionally metamorphosed to amphibolite facies grade and have been extensively deformed during the Grenville Orogeny. The oldest units comprise migmatites, banded gneiss, and metamorphosed clastic sedimentary rocks which form the Burleigh Gneiss Complex. These clastic metasediments grade upwards into calcite-rich metasediments and marbles which are in turn unconformably overlain by a relatively thick succession of metavolcanics. The metavolcanics can be divided into 3 groups: a lower mafic group composed of tholeiitic flows, flow breccias, and amygdaloidal flows; an upper mafic group composed dominantly of aluminium-rich feldspar-phyric basalts; and a felsic group composed of dacite-rhyolite flow fragmental rocks, and intrusions. These volcanic rocks lie in a southward-plunging northeast-trending syncline which underlies the central part of Harvey Township.

Granite and granodiorite plutons and smaller intrusions range from gabbro to quartz monsonite in composition, and have intruded the volcanic-sedimentary succession.

Small copper occurrences are related to felsic and mafic volcanic rocks and chemically derived metasediments. Copper and molybdenite are found in shallow intrusive rocks. Minor quantities of uranium are associated with pegmatite dikes and sills.

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CONVERSION FACTORS FOR MEASUREMENTS IN ONTARIO GEOLOGICAL SURVEY PUBLICATIONS

If the reader wishes to convert imperial units to SI (metric) units or SI units to imperial units the following multipliers should be used:

CONVERSION FROM SI TO IMPERIAL			CONVERSION FROM IMPERIAL TO SI		
SI Unit	*Multiplied by*	*Gives*	*Imperial Unit*	*Multiplied by*	*Gives*
			LENGTH		
1 mm	0.039 37	inches	1 inch	**25.4**	mm
1 cm	0.393 70	inches	1 inch	**2.54**	cm
1 m	3.280 84	feet	1 foot	**0.304 8**	m
1 m	0.049 709 7	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	**1.609 344**	km
			AREA		
1 cm^2	0.155 0	square inches	1 square inch	**6.451 6**	cm^2
1 m^2	10.763 9	square feet	1 square foot	**0.092 903 04**	m^2
1 km^2	0.386 10	square miles	1 square mile	2.589 988	km^2
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
			VOLUME		
1 cm^3	0.061 02	cubic inches	1 cubic inch	**16.387 064**	cm^3
1 m^3	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m^3
1 m^3	1.308 0	cubic yards	1 cubic yard	0.764 555	m^3
			CAPACITY		
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	**4.546 090**	L
			MASS		
1 g	0.035 273 96	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 75	ounces (troy)	1 ounce (troy)	**31.103 476 8**	g
1 kg	2.204 62	pounds (avdp)	1 pound (avdp)	**0.453 592 37**	kg
1 kg	0.001 102 3	tons (short)	1 ton (short)	907.184 74	kg
1 t	1.102 311	tons (short)	1 ton (short)	**0.907 184 74**	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	**1016.046 908 8**	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	**1.016 046 908 8**	t
			CONCENTRATION		
1 g/t	0.029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

1 ounce (troy)/ton (short)	20.0	pennyweights/ton (short)
1 pennyweight/ton (short)	0.05	ounce (troy)/ton (short)

NOTE–Conversion factors which are in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries published by The Mining Association of Canada in co-operation with the Coal Association of Canada.

Geology of
Harvey Township
Peterborough County

By

R.L. Morton[1]

INTRODUCTION

This report presents the results of a detailed geological survey of some 320 km² within Harvey Township, Peterborough County, Southeastern Ontario (Figure 1). The villages of Buckhorn and Burleigh Falls in the south-central and southeastern parts of the township, respectively, are the main centres of population. The town of Bobcaygeon is located immediately west of the map area.

Mineral exploration within the area has been sporadic; most of the activity was restricted to the period between 1950 and 1960. Most of this activity was directed towards the search for uranium; the small occurrences of copper have received little or no attention.

Methods

Geological mapping was carried out by the author, Dr. Avril Gunter, Davia Lefebure, and their assistants (Steve Switzer and Kathy Brind 'Amour) from early May to late August 1978. Mapping was done by pace and compass traverses run perpendicular to the strike of metavolcanic and metasedimentary rock units, and by direct location in open areas. The geological data were plotted directly on acetate sheets fitted over topographic base maps at the scale of 4 inches to 1 mile. The data were subsequently transferred to base maps of the same scale prepared by the Cartography Section, Surveys and Mapping Branch, Lands and Waters Group from maps of the Forestry Resources Inventory. Traverses were generally spaced ¼ mile apart in areas underlain by metavolcanic and metasedimentary rocks, and ½ to ¾ of a mile apart within the

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Burleigh Gneiss Complex. Areas of particular interest were mapped in greater detail. Areas underlain by Paleozoic limestone (Bobcaygeon Formation) were plotted, but were not studied in any detail.

Previous Geological Work

Adams and Barlow (1910) carried out reconnaissance geological mapping within Harvey Township, and as far as is known by the author, this was the only survey of the Precambrian rocks until the present study. Satterly (1956), as part of a uranium study, examined and collected data on most of the known uranium occurrences within the township.

References for the Paleozoic geology can be found in Hewitt (1972) and Liberty (1969).

The Burleigh Falls aeromagnetic sheet (Map 1036, Geological Survey of Canada, 1949) includes the present map area.

Acknowledgments

During the 1978 field season, parts of Harvey Township underlain by Precambrian rocks were mapped by Dr. Avril Gunter,and Davia Lefebure. The author was ably assisted by Steve Switzer and Kathy Brind 'Amour.

The cooperation of all residents of the area, especially those on whose land the mapping was carried out, is greatly appreciated.

Petrological studies for this report were carried out by the author in the Department of Geology, Carleton University. Certain aspects of the petrology of the metavolcanics are based on chemical analyses done by the Geoscience Laboratories, Ontario Geological Survey, Toronto. Mr. S. Switzer drafted the final "field" maps which were then amalgamated into 1 map by the Cartographic Section, Ontario Ministry of Natural Resources (*see* Map 2475, back pocket).

Access

In 1978, much of the map area was accessible by road except for the northeastern part. Highways 36 and 507 cross the area. From these major highways, township, private cottage, and farm roads provide adequate access into the hinterland.

Physiography

The average elevation in the area is about 300 m above sea level. The lowest elevations occur along Nogies Creek, around Pigeon and Buckhorn Lakes, and along the Squaw River (270 m). The highest elevation is found east of the

Mississagua River (330 m). In general, the western, central, and north-central parts of the map area are relatively flat. Swampy areas and small lakes are separated by low, rocky ridges. The eastern parts of the area are slightly more rugged and consist of low, rolling hills separated by narrow,elongate swamps. All of the rivers and lakes within Harvey Township drain southwards into Lake Ontario.

Bedrock exposure is excellent in areas underlain by the major plutonic bodies and within the area underlain by migmatites, and exposures typically exceed 40 percent of the surface. Metavolcanics are less consistently exposed, and some of the areas underlain by metasediments have only a few percent of their areas exposed. The largest swamps are located in areas underlain by mafic rocks, chemical metasediments, fragmental metavolcanics, and marbles. These swamps occur mainly west and east of Nogies Creek, in the northern part of the area, and west and east of the Squaw River in the southern and central parts of the township. Scattered outcrops are easily mapped on small farms which are scattered along the main routes; but relations between complex units, particularly in the metavolcanics, are difficult to establish because outcrops are sparse in the swamps and forest which cover a major part of the area. Excellent exposures occur in road cuts on Highways 36 and 507, along lake shores, and along the Mississagua River.

GENERAL GEOLOGY

The map area is underlain by almost equal amounts of migmatite, banded gneiss, granitic plutons, and metavolcanics and metasediments (Figure 2). The area lies within the Central Metasedimentary Belt of the Southern Grenville Structural Province (Wynne-Edwards 1972). The lithological units are given in Table 1.

The Burleigh Gneiss Complex underlies the entire eastern part of the map area (Figure 2) and contains the oldest rocks exposed in Harvey Township. The Burleigh Gneiss Complex can be divided into 2 distinct units. These are an inner core zone composed of nebulitic and layered migmatite, migmatitic granodiorite, and an outer zone composed of banded gneiss. Rocks of the outer zone grade westwards into bedded, clastic metasediments which are interlayered with, and are overlain by, a conformable succession of calcitic and dolomitic marble.

These carbonate-rich rocks are overlain unconformably by a complex succession of rocks. These rocks consist of: mafic to felsic metavolcanic flows; flow breccias; pyroclastic flows; debris deposits; small sills, dikes, and stocks; and fine- to medium-grained volcaniclastic rocks. The volcanic succession has an apparent maximum thickness of 3.2 km.

All these above rock units are intruded by granite and granodiorite plutons. These plutonic rocks are common within the Burleigh Gneiss Complex and in the northwestern part of the map area.

Intrusive relationships indicate that these granitic rocks can be subdivided into three distinct types:

1. Biotite-hornblende granodiorite underlies the northwest and north-central part of Harvey Township. This unit contains xenoliths of fel-

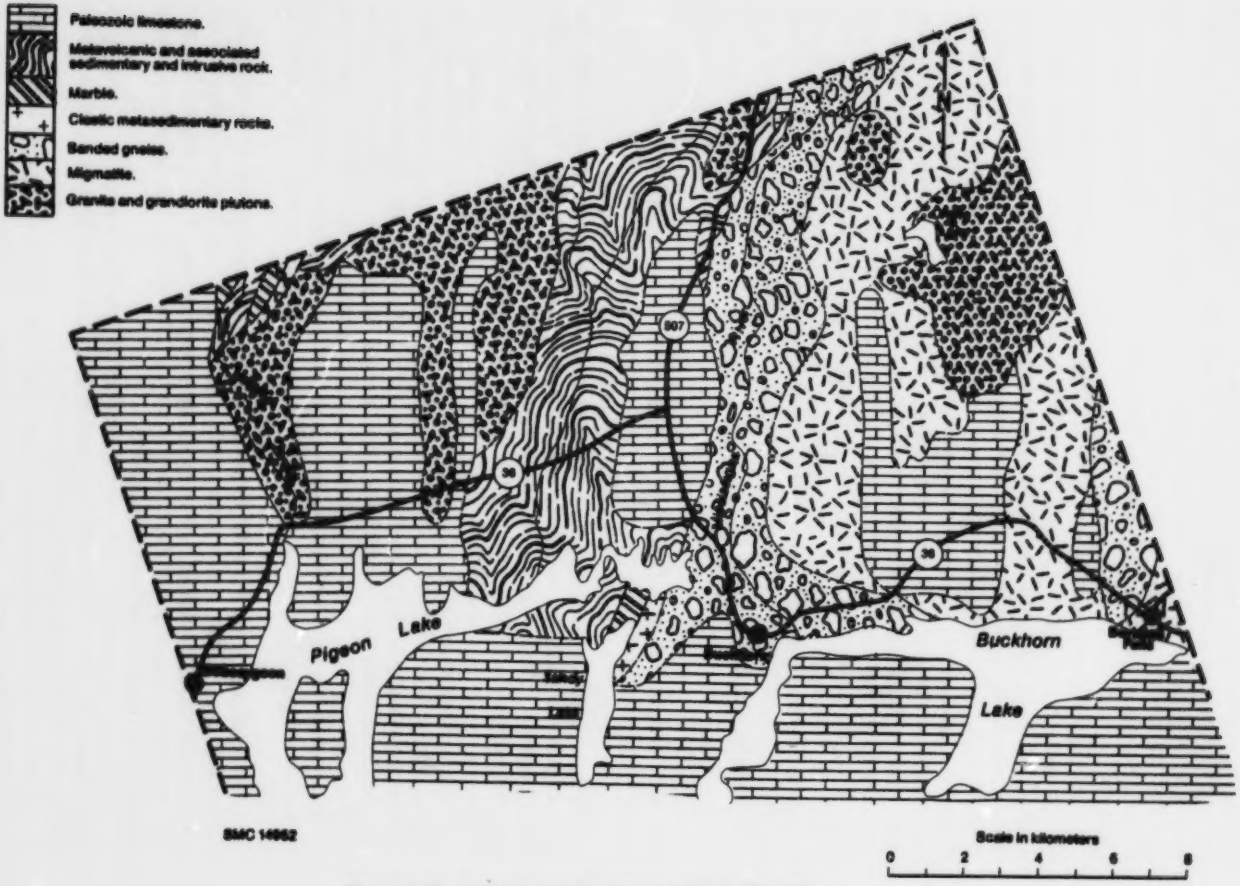

Figure 2–Generalized geological map of Harvey Township.

sic-to-mafic-metavolcanics, exhibits 2 well-defined foliations, and is intruded by the granitic rocks of types 2 and 3 which succeed type 1 in this account.

2. Fresh to weakly foliated granite to granodiorite stocks, dikes, and plutons.

3. Pegmatite dikes and sills.

The structure of the map area is complex. All the major lithologic units as well as the plutons were regionally metamorphosed, and, with the exception of type 2 and 3 granites, have undergone at least 2 and possibly 3 phases of deformation. Penetrative deformation outlasted most of the metamorphic activity.

Much of the map area, particularly the southern part, is underlain by limestone of Ordovician age.

Late Precambrian

BURLEIGH GNEISS COMPLEX[1]

Layered and Nebulitic Migmatite and Migmatitic Granodiorite and Quartz Diorite

Layered and nebulitic migmatite with more localized zones of homogeneous migmatitic granodiorite underlie a 6 by 13 km area in the eastern part of Harvey Township and form the core of the Burleigh Gneiss Complex. Nebulitic migmatite occupies the outer part of the core zone. To the west, contacts of this rock, with the overlying banded gneiss are; either covered by Paleozoic limestone, marked by zones of intense shearing and granulation, or appear to be gradational. To the east, nebulitic migmatite grades into well-layered migmatite over a 50 to 300 m wide area. In this rock, veins (3 mm to 8 cm thick), diffuse swirls (106 cm in diameter), and distinct subrounded to elongate blebs (102 cm in diameter) of pinkish grey, granitic material with a colour index of less than 5, appear to coalesce to form lenses (10 cm to 4 m) and layers (1 m to 15 m) in a grey, finer grained more plagioclase- and biotite-rich matrix with a colour index of 15 to 25.

Nebulitic migmatites (Photo 1) are typically mottled pink and grey, are locally pinkish grey, and are composed of veins, blebs and diffuse areas of fine- to medium-grained orthoclase and/or microcline, quartz, and oligoclase-andesine with minor amounts of biotite (up to 5 percent), magnetite, and hematite. These areas of nebulitic migmatite are enclosed by a finer grained matrix of oligoclase-andesine, quartz, and biotite with minor quantities of orthoclase, hornblende, magnetite, hematite, and apatite. Thin section examination reveals that it is difficult to separate matrix material from diffuse areas of orthoclase

[1]The many Burleigh Gneiss Complex lithologies described in some detail in this report are grouped as "banded quartz-feldspar-biotite gneiss", "feldspar-quartz-biotite layered and nebulitic migmatite"; "migmatitic granodiorite", and "quartz diorite" on the geological map that accompanies the report (Map 2475, back pocket). The complexity of the Burleigh Gneiss Complex cannot be shown on this map which is published at a scale of 1:31 680 (1 inch to ½ mile).

TABLE 1 TABLE OF LITHOLOGIC UNITS FOR HARVEY TOWNSHIP AREA.

PHANEROZOIC

CENOZOIC

QUATERNARY

PLEISTOCENE AND RECENT

Local fluvial and lacustrine deposits, sand, gravel, sandy and silty boulder clay, varved clay, swamp accumulations.

Unconformity

PALEOZOIC

ORDOVICIAN

Lithographic limestone, fossiliferous limestone, limestone breccia, calcareous shale, lithic wacke, quartz wacke, polymictic conglomerate, sandy shale.

Unconformity

PRECAMBRIAN

LATE PRECAMBRIAN

MAFIC INTRUSIVE ROCKS

Diabase.

Intrusive Contact

LATE FELSIC INTRUSIVE ROCKS

Pegmatitic granite and granodiorite.

Intrusive Contact

METAMORPHOSED FELSIC INTRUSIVE ROCKS

Granite, granodiorite, peristerite-bearing granite and granodiorite, aplitic granite, minor alaskite.

Intrusive Contact

METAMORPHOSED INTERMEDIATE INTRUSIVE ROCKS

Biotite granodiorite, quartz diorite, hornblende granodiorite and quartz diorite.

Intrusive Contact

METAMORPHOSED INTERMEDIATE TO MAFIC INTRUSIVE ROCKS

Quartz monzonite, quartz diorite, minor monzonite, gneissic gabbro, hornblendite, hornblende schist, metaperidotite.

METAVOLCANICS AND METASEDIMENTS

UPPER METASEDIMENTS[a]

CLASTIC METASEDIMENTS

Biotite schist, muscovite schist, quartz-plagioclase-biotite schist and gneiss, minor wacke, siltstone, conglomerate, and sillimanite-bearing schist.[b]

CHEMICAL METASEDIMENTS

Muscovite-quartz pyrite schist, quartz-rich metatuff chert, calcite-quartz schist, feldspar-biotite schist, quartz-biotite schist and gneiss, minor marble, iron formation, amphibolite, metarhyolite.

METAVOLCANICS[d]

MAFIC TO FELSIC METAVOLCANICS

Lapilli tuff, bedded tuff, fragment-rich ash flow tuff, debris flow deposits, minor bedded sediments, flows, flow breccias, fragment-poor ash flow tuff, dikes, sills, small intrusions, potassium feldspar-biotite schist and gneiss.[e]

MAFIC METAVOLCANICS

Porphyritic flows, massive flows, amygdaloidal flows, autoclastic and flow breccias, amphibolite, banded amphibolite, bedded hornblende schist, hornblende-biotite-garnet schist, mafic dikes and sills.

LOWER METASEDIMENTS

CHEMICAL METASEDIMENTS

Calcitic marble, tremolite-actinolite bearing marble, dolomitic marble.

CLASTIC METASEDIMENTS

Sandstone, pebble conglomerate, siltstone, biotite-rich to biotite-poor quartz-feldspar gneiss, minor quartz schist.

BURLEIGH GNEISS COMPLEX[d]

Banded quartz-feldspar-biotite gneiss[c], feldspar-quartz-biotite-layered and nebulitic migmatite, migmatitic granodiorite, and quartz diorite.

Footnotes
(a)The rocks of these groups are subdivided lithologically and the order does not imply age relationships.
(b)Volcanic mudstone.
(c)Associated with felsic breccias and flows.
(d)Multiple ages are probably represented, i.e. both rocks of the Pre-Grenville and Grenville Provinces.
(e)Includes up to 50% sills and dikes of units 11 and 12.

and quartz; however, blebs and veins exhibit sharp contacts which may be outlined by a narrow zone 0.05 to 0.5 mm wide composed of biotite and magnetite. Blebs and swirls of material compose 10 to 60 percent of the rock and the percentage increases towards the layered migmatite.

Nebulitic migmatite exhibits a lenticular foliation defined by aggregates and blebs of quartz and orthoclase, and biotite aggregates in the granodioritic matrix. A lineation is also defined by quartz spindles which are 0.5 to 5 mm long. These structures are conformable with those in the overlying metavolcanics, metasediments, and banded gneiss except for the granulated and sheared contact zones. Within these, foliation and lineation deviate from the regional trend and parallel the direction of shearing and granulation. Blebs and diffuse areas in the migmatite are elongated and "streaked" in the direction of the contact with banded gneiss, or are broken into aggregates of recrystallized grains.

Migmatitic granodiorite is grey, pinkish grey, and varies from fine to coarse grained and varies from granite to a granodiorite in composition. Layers are well defined. The layers contain lenses and bands 1 cm to 1.5 m wide composed of granoblastic granite consisting of orthoclase and/or microcline, quartz, and plagioclase, minor amounts of biotite and magnetite, that alternate with more continuous areas of granodiorite consisting of oligoclase-andesine, quartz, biotite, and orthoclase, and minor amounts of hornblende, magnetite, epidote, and apatite. These rocks are well foliated. Hornblende with quartz exhibits a well-defined lineation. These structures parallel those in the nebulitic migmatite and migmatitic granodiorite.

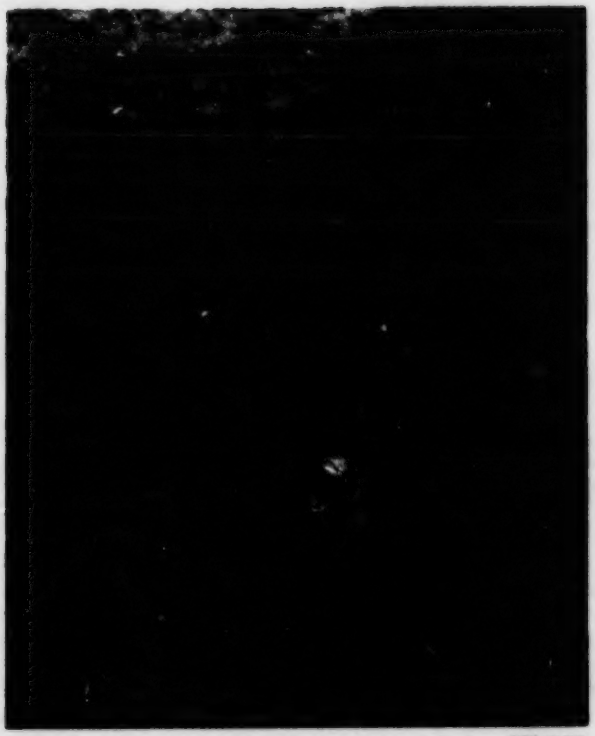

Photo 1–Nebulitic migmatite. Blebs and veins of quartz and orthoclase in a grey granodiorite matrix.

Blocks of layered migmatite, 50 by 150 to 300 by 600 m in size are surrounded by nebulitic migmatite adjacent to Crane Lake and 2 km northeast of the Mississagua River across from Rockcroft. Contacts are generally obscured by overburden, but the elongation of swamps and drainage patterns of small creeks in the contact zone suggest that these areas of migmatite are fault blocks.

Areas of homogeneous granodiorite occur throughout the complex and range from a few metres to tens of metres in length. These granoblastic, medium-grained rocks are greyish pink to grey in hand specimen, and are composed of oligoclase-andesine, quartz, biotite, hornblende, orthoclase, magnetite-hematite, apatite, and allanite.

Contacts between areas of homogeneous "granodiorite" and migmatite vary from being gradational to sharp; where contacts are sharply defined, granodiorite is less than 10 m wide and occurs as distinct bands through adjacent migmatite. This relationship suggests sills or dike-like bodies exist. Granodiorite could represent orthogneisses derived from earlier, small granodiorite to quartz diorite intrusions.

All of the above rock units are intruded by granite to granodiorite dikes, sills, and larger, more irregularly-shaped plutonic bodies, and pegmatite dikes and sills. Xenoliths of amphibolite, quartz-feldspar gneiss, and various biotite-quartz-feldspar schists occur within the outer part of the migmatite complex.

Banded Quartz-Feldspar Gneiss

These compositionally complex rocks encircle the migmatite zone and form the margins of the Burleigh Gneiss Complex (Figure 2). These rocks are widely exposed at the following localities: east of the Mississagua River; south of Mississagua Lake; east of Highway 36 between Buckhorn and Flynn's Turn, and north of Highway 36 between Buckhorn and Burleigh Falls. The banded gneiss composes 35 percent of the Burleigh Gneiss Complex and is variable in composition. In general, hornblende and biotite decrease, and quartz and potassic feldspar increase in abundance from east to west. About two-thirds of the banded gneiss is composed of quartz-feldspar-biotite gneiss which locally exhibits relict bedding; graded bedding and crossbedding are uncommon. West of Buckhorn, are exposed a series of compositionally and texturally similar clastic metasediments.

The banded gneiss unit can be divided into three types: 1) mafic gneiss and schist, 2) quartz-plagioclase-biotite gneiss, and 3) felsic gneiss. [Please note these rocks are not mentioned specifically in the map legend or in Table 1 for reasons given in the footnote on page 5].

Mafic gneiss and schists are generally found only in the lowermost parts of the banded gneiss unit; they are most abundant east of the Mississagua River between Rockcroft and Flynn's Turn, and northeast of Buckhorn. These rocks compose an estimated 15 percent of Unit 1.

These rocks have a colour index which ranges from 20 to 45. The texture varies from fine to medium grained, and from blackish grey to grey (Photo 2). In order of decreasing abundance, these rocks are composed of varying amounts of plagioclase, hornblende, biotite, and quartz with less quantities of potassic feldspar, carbonate, garnet, staurolite, magnetite-hematite, tourmaline, and pyrite (*see* Table 2). Garnet and hornblende porphyroblasts are found locally and these vary from 3 mm up to 2 cm in diameter, are invariably poikiloblastic, and compose from 5 to 15 percent of the rock. Mafic gneiss is compositionally banded with individual layers ranging from 2 cm to 1 m; bands commonly alternate from being composed mainly of hornblende, plagioclase, or biotite-plagioclase-quartz, and plagioclase and quartz.

Thin units of fine- to medium-grained grey and bluish grey marble are interlayered with the mafic gneisses. Marble layers range from 5 cm to 5 m in thickness, are complexly distorted and folded, and are composed dominantly of

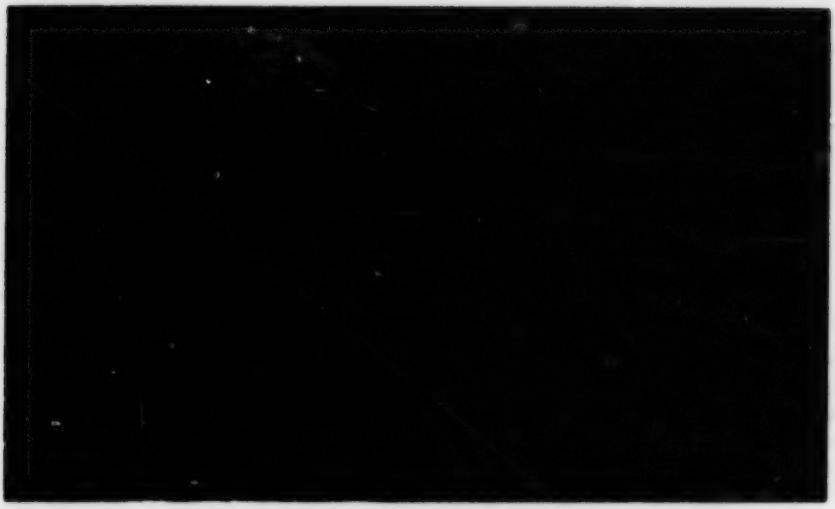

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Photo 2–Banded gneiss cut by a pegmatite dike.

calcite with minor quartz, tremolite, and hornblende. In places, the marbles are overlain by carbonate-rich biotite-quartz schists which grade upward into carbonate free biotite-quartz schists. The marble layers are too small to place on the map face (see Map 2475, back pocket).

Quartz-plagioclase-biotite gneiss, biotite-plagioclase gneiss, and schist and plagioclase-quartz gneiss are the most abundant rocks of Unit 1 and are exposed east of the Mississagua River from Mississagua Lake to Buckhorn. These greyish black to grey rocks exhibit a well-defined compositional layering with individual layers varying from 1 cm to 1.5 m in thickness. Layering is defined by quartz and plagioclase alternating with biotite-plagioclase-rich bands.

These rocks are composed of varying amounts of oligoclase-andesine, quartz and dark brown biotite with minor amounts of orthoclase, microcline, magnetite-hematite, garnet, tourmaline, muscovite, apatite, zircon, pyrite, and staurolite. Biotite, microcline, and garnet can form porphyroblasts, but generally, the rocks are fine to medium grained and equigranular. In places, the rocks have been recrystallized to knots and aggregates of quartz and plagioclase with ragged and distorted flakes of biotite scattered throughout. Carbonate-bearing rocks are generally absent from this sequence.

TABLE 2 AVERAGE MODAL COMPOSITIONS OF METAVOLCANIC AND ASSOCIATED INTRUSIVE ROCKS, HARVEY TOWNSHIP AREA.

Unit[1]	4a	4b	4c[2]	5a	5b	5c	6a[4]	6a	11a	9b
Minerals										
Plagioclase	59	50	51	44	40	8	49	50	41	36
K-Feldspar	—	—	—	24	30	45	22	—	—	30
Quartz	1	Tr	Tr	19	15	15	13	1	1	15
Biotite	3	1	2	6	12	30	15	—	—	13
Hornblende	32	39	36	—	—	—	—	40	44	5
Muscovite	—	—	—	4	1	2	Tr	—	—	Tr
Actinolite	—	—	1	—	—	—	—	—	3	—
Epidote	3	3	1	—	—	—	—	5	6	—
Mag + Hem + Py[5]	2	2	1	1	1	Tr	1	1	2	Tr
Ti	Tr	Tr	2	Tr	—	—	—	2	3	Tr
Carbonate	—	1	2	1	1	—	Tr	1	Tr	Tr
Apatite	Tr	1	1	Tr	Tr	Tr	Tr	Tr	1	Tr
Talc	—	3	—	—	—	—	—	—	—	—
Garnet	—	—	3	1	—	—	—	—	Tr	Tr
Sample Number	5	5	5[3]	8	4	2	2	1	4	6

Footnotes

1) Refers to Rock Unit on geology map of Harvey Township (Map 2475, back pocket).
2) Does not include two Bio-Carb rocks mapped with Unit 4c which possibly represent tuff or sediments (0.091mm, 0.045mm).
3) Felsic types.
4) Mafic type.
5) Mag-magnetite, Hem-hematite, Py-pyrite.

These rocks are gradational into the felsic gneiss unit, but are distinguished from it by the absence of magnetite porphyroblasts, abundance of biotite, and by only small amounts of orthoclase, the lack of relict textures, and their dark grey colour.

Felsic gneiss underlies the area immediately west of the Mississagua River between Buckhorn and Mississagua Lake. Relict features such as bedding, crossbedding, and colour gradation are locally prominent, top directions from such features face consistently west.

Crossbedding is marked by magnetite-hematite-rich laminae with foresets varying from 5 to 2 cm in thickness. Colour gradations are caused by varying proportions of magnetite-hematite, biotite, quartz, and orthoclase. These pinkish grey to buff, medium-grained rocks mainly comprise varying proportions of

quartz, potassic feldspar, plagioclase, biotite, and magnetite with minor amounts of muscovite, tourmaline, and garnet. Magnetite forms porphyroblasts throughout, whereas microcline and muscovite locally are porphyroblastic.

West of Mississagua Lake, numerous amphibolite and gneissic gabbro dikes and sills are interlayered with or cut across the bedding of the felsic gneisses.

METAVOLCANICS AND METASEDIMENTS

Lower Metasediments

CLASTIC METASEDIMENTS[1]

Clastic siliceous metasediments, composed mainly of well-foliated *feldspathic wacke* with minor amounts of pebble conglomerate and siltstone, are exposed immediately west of Buckhorn on the south side of Big Bald Lake, and immediately east of Nogies Creek in the northwest part of the map area. These rocks have a maximum exposed thickness of 330 m. They grade upwards into carbonate-rich metasediments which are conformably overlain by marble.

Wacke exhibits relict bedding and graded bedding. Individual beds range from 1 cm to 20 cm in thickness, and exhibit flame and slump structures. Graded bedding is only locally discernible in outcrop, and cannot be determined with ease from thin section examination. Where observed, fine-grained quartz and orthoclase gradually give way to coarser grained plagioclase, quartz, and biotite; each bed is succeeded by a sharp contact at the base of the next graded bed.

Wackes are light grey to buff-coloured rocks which are fine to medium grained and granoblastic. These rocks are composed of varying amounts of quartz, plagioclase, potassic feldspar, and biotite with accessory carbonate, magnetite-hematite, *garnet*, hornblende, apatite and pyrite. Garnet and hornblende form porphyroblasts in more carbonate-rich rocks, whereas microcline porphyroblasts are common in more potassic feldspar-rich rocks. The quartz content of these rocks varies from 20 to 60 percent, potassic feldspar from 5 to 35 percent, and pale to dark brown biotite from 0 to 30 percent. Carbonate-rich members have a similar lithology, but carbonate varies from 10 to 30 percent.

A narrow lens of pebble conglomerate is exposed east of Nogies Creek; this lens is 10 m long and 5 m thick grading both upwards and downwards into *feldspathic wacke*. Feldspathic wacke forms the matrix of the conglomerate, and pebbles compose from 20 to 40 percent of the rock. These consist of coarse-

[1]Rocks/minerals in italics are not in legend of Map 2475, back pocket because they are present on too small a scale to be plotted on the map.

grained quartz, fine-grained granular *feldspathic wacke*, *calcite marble*, quartz schist, and very fine grained, laminated *siltstone*; no granitic or metavolcanic pebbles were observed. Pebbles range in size from 5 mm to 5 cm, are subrounded to subangular, and exhibit a distinct alignment which conforms to that of the surrounding rocks. These metasediments may correlate with Bright's (1977) Anstruther Lake Unit.

CHEMICAL METASEDIMENTS

Carbonate-bearing metasediments conformably overlie and gradationally change from rocks of Unit 1 (Map 2475, back pocket). These chemical metasediments are unconformably overlain by a thick succession of mafic to felsic metavolcanics. Marbles are most abundant in the northwest part of the map area, and are exposed on the west and east sides of Nogies Creek. At this locality, these rocks have been folded with mafic metavolcanics to form a series of southward-plunging anticlines and synclines [not marked on Map 2475, back pocket]. The maximum thickness of any one marble band is 0.8 km. Marbles are also exposed north of Sandy Lake where again they are folded with the metavolcanics. The exposed thickness of the marble unit at this location is 1.2 km, but may comprise units repeated by folding.

These metasediments consist of massive or layered white, grey, bluish grey, dark grey and greenish grey fine- to coarse-grained marble. Varieties dominated by calcite and dolomite can be distinguished. Calcitic marble is far more abundant than dolomitic marble in the map area. All units contain quartz which varies from trace amounts to 35 percent. At one locality east of Nogies Creek, fine-grained chert forms subrounded to elongated nodules in the calcitic marble. The nodules are cemented by medium-grained quartz and carbonate and vary from 2 mm to 4 cm in diameter, and make up 10 to 30 percent of the rock. In a few places, such as west of Nogies Creek, actinolite and tremolite are locally abundant. The tremolite occurs as small, single crystals, and as sheaves of crystals with a maximum length of 3 cm and can constitute 15 percent of the marble. Dark green, prismatic actinolite, up to 8 cm long, and radiating sheaves of actinolite crystals as much as 4 cm in length make up 20 percent of a single marble layer. Fine-grained disseminated pyrite is locally abundant west of Nogies Creek and north of Sandy Lake. Traces of sphalerite and galena also occur at the previously mentioned Sandy Lake location.

Original bedding is locally evident, particularly in marbles which are exposed in the northwestern corner of the map area. Bedding is defined by colour layering, concentrations of actinolite and tremolite in layers 2 mm to 8 cm thick, and by fine interbeds of calcareous siltstone [too fine to be shown on map scale] containing up to 35 percent biotite, quartz, and plagioclase. In the northwest part of the map area, east of Nogies Creek, layered marbles (layering is represented by colour banding) are angularly overlain, (up to 30°), by mafic basalts.

Marbles are intruded by gneissic gabbro, fine- to medium-grained amphibolite, and granitic and pegmatitic dikes and sills. North of Sandy Lake, a coarse-grained hornblende-bearing rock forms sharp contacts with medium-grained marble, contains small marble fragments, and is a maximum of 3 m

wide. The rock is composed of coarse-grained hornblende (45 percent), garnet (25 percent), actinolite (10 percent), epidote (10 percent), biotite (3 percent), plagioclase (5 percent), and magnetite (2 percent). The origin of this rock has not been determined.

METAVOLCANICS

Within the map area, metavolcanics are found in two separate areas:

1. In the central part of Harvey Township from Sandy Lake north to Mississagua Lake where they form a broad, gently-plunging syncline;
2. North and south of Nogies Creek where mafic basalts are folded with, and structurally overlie carbonate metasediments.

Metavolcanics underlie some 100 km^2 of Harvey Township and have an exposed maximum thickness of 3.2 km. Metavolcanics are lithologically classified into several types on the basis of: 1) mineralogical composition; 2) contact relationships; and 3) preserved, primary structures and textures. Data available permit a general interpretation to be made of the primary lithology and origin of these rocks.

Several features of the metavolcanics, such as intense recrystallization and penetrative deformation, folding, and lateral gradation of one lithology into another seriously hinder a hypothetical reconstruction of the stratigraphic section. Nevertheless, the following features allow a tentative interpretation of the stratigraphic section to be made; 1) preserved textures indicative of top directions; 2) relative continuity of lithological units; 3) continuity of lithological units within major folds; and 4) the progression of rock types within the *major syncline* in the area [The syncline is not shown on Map 2475, back pocket].

In general, the metavolcanics are characterized by;

1. mafic metavolcanics (SiO_2 52 percent, colour index greater than 35 percent)
2. felsic metavolcanics (SiO_2 62 percent, colour index less than 15 percent)
3. rocks of intermediate composition appear to be absent

Mafic Metavolcanics

Mafic metavolcanics of basaltic composition (Table 3), the oldest and most abundant rocks of the volcanic succession, are widely distributed as massive and amygdaloidal flows, autoclastic breccias, and feldspar-phyric flows. Exposures indicate a minimum exposed thickness of 2.3 km in which individual flows vary from 1 m to 20 m in thickness. The lower boundary of the unit is represented by very fine to fine grained aphyric to amygdaloidal, mafic flows (colour index greater than 45) which unconformably overlie marble east of Nogies Creek, and banded gneiss west and southwest of Mississagua Lake. North of Sandy Lake and west of Mississagua Lake, tops within mafic basalts face consistently west. This corresponds to their position on the eastern limb of a large syncline.

TABLE 3 | AVERAGE CHEMICAL ANALYSES OF METAVOLCANICS, HARVEY TOWNSHIP.

Major Component	Basalt	Feldspar-Phyric Basalt	Ultramafics	Gabbro	Dacite-Rhyolite Flows, Ash Tuffs	Dacite-Rhyolite Fragmental Rocks	Dacite Intrusives	Quartz Monzonite
SiO_2	45.8	49.4	43.6	45.8	66.2	58.2	63.8	58.5
Al_2O_3	15.2	19.5	14.0	15.0	16.7	17.3	16.5	14.2
Fe_2O_3*	14.8	10.6	13.9	15.4	4.8	7.3	5.1	12.1
MgO	6.4	3.9	3.9	6.4	0.5	2.1	0.8	0.9
CaO	10.6	10.0	19.2	10.0	1.1	3.0	1.6	2.2
Na_2O	2.6	3.6	1.0	2.2	5.9	5.5	6.0	4.2
K_2O	0.5	0.6	0.2	0.3	2.5	2.0	3.8	4.3
TiO_2	2.0	1.3	1.8	2.5	0.6	1.2	0.5	1.2
MnO	0.2	0.2	0.3	0.2	0.1	0.1	0.1	0.3
P_2O_5	0.3	0.3	0.3	0.3	0.1	0.4	0.2	0.2
CO_2	0.5	0.4	1.0	1.2	0.4	0.6	0.6	1.4
L.O.I.	0.8	0.8	0.6	1.7	0.6	1.1	0.9	1.4
TOTAL	99.7	100.6	99.8	101.0	99.5	98.8	99.1	100.9
N	7	4	2	2	5	2	2	2
NORM. C.I.	44	29	51	46	7	15	12	23

Footnote

Chemical analyses performed by Geoscience Laboratories, Ontario Geological Survey, Toronto.

* Represents total iron.

L.O.I. Loss on ignition.

N — Number of samples analyzed.

NORM C.I. — Normative colour index.

The lowermost rocks at the base of the metavolcanics are composed dominantly of amphibolite, banded amphibolite and hornblende schist, with smaller amounts of amygdaloidal *basalt* [too thin to show at map scale], autoclastic flow and breccia, and bedded hornblende-garnet schist. Feldspar-phyric flows are absent from this basal succession.

These black to greenish black and dark grey rocks have a colour index greater than 40 percent and have a relatively uniform composition of olivine tholeiite and tholeiite. They are typically composed of varying proportions of oligoclase-andesine, and hornblende with minor amounts of epidote, talc, magnetite, carbonate, titanite, apatite, quartz, actinolite, and *garnet* (see Table 2). Talc and actinolite are locally abundant, such as west of Nogies Creek and north of Sandy Lake, and can compose up to 20 percent of the rock. Titanite ranges from 1 to 4 percent by volume. Hornblende, and uncommonly, garnet locally form porphyroblasts which vary from 2 mm to 2 cm in diameter, are invariably poikilitic, and compose from 5 to 20 percent of the rock. Amygdules are locally abundant, at localities such as those north of Little and Big Bald Lakes, and west of Nogies Creek. Amygdules make up 5 to 15 percent of individual flows and are subrounded to elongate and flattened. Amygdules range from 2 mm to 11 cm in length. They are filled by carbonate, quartz, epidote, actinolite, plagioclase, magnetite, and pyrite with minor amounts of chalcopyrite. Amygdaloidal flows are estimated to compose some 15 percent of this lowermost succession.

Interlayered with the mafic metavolcanics are bedded to massive rocks interpreted to be *basaltic metasediments* [not on Map 2475, because these rocks are too thin to show at map scale]. These fine- to medium-grained grey and dark grey rocks are composed of plagioclase, hornblende, epidote, biotite, calcite, and *garnet* with accessory quartz, magnetite-hematite, pyrite, chalcopyrite, and arsenopyrite. Basalt clasts are common, colour layering occurs locally, and garnet and hornblende porphyroblasts may be present. Individual beds range from 3 cm to 3 m in thickness, with a maximum uninterrupted thickness for the unit of 15 m (north of Little and Big Bald Lakes). These rocks constitute an estimated 5 percent of the mafic succession, and are conspicuously absent in the upper part of it.

The basal mafic metavolcanics grade westwards from Mississagua Lake and eastwards from Nogies Creek into less mafic flows (colour index of 30 to 45 percent) typified by fine- to coarse-grained relicts of plagioclase phenocrysts (Photo 3) and by amygdaloidal flows and autoclastic flow breccias. The relative percentage of amphibolite and banded amphibolite is markedly reduced. These rocks tend to become more feldspar-rich and amygdaloidal towards the top of the succession where they are interlayered with felsic metavolcanics, and more locally, with epiclastic metasediments. Close to the top of this succession, fragments of rhyolite-dacite occur in the flows, and basalt fragments are found in adjacent felsic metavolcanic deposits. The maximum exposed thickness of the upper flows is 0.8 km.

These mafic flows display a wide variety of primary textures and structures such as; grain gradation within flows, chilled flow contacts, amygdules, relict plagioclase phenocrysts, and flow top and bottom breccias. Pillowed lavas appear to be absent from the succession. Primary features are variably deformed, but clearly evident where the strain has been mainly extensional.

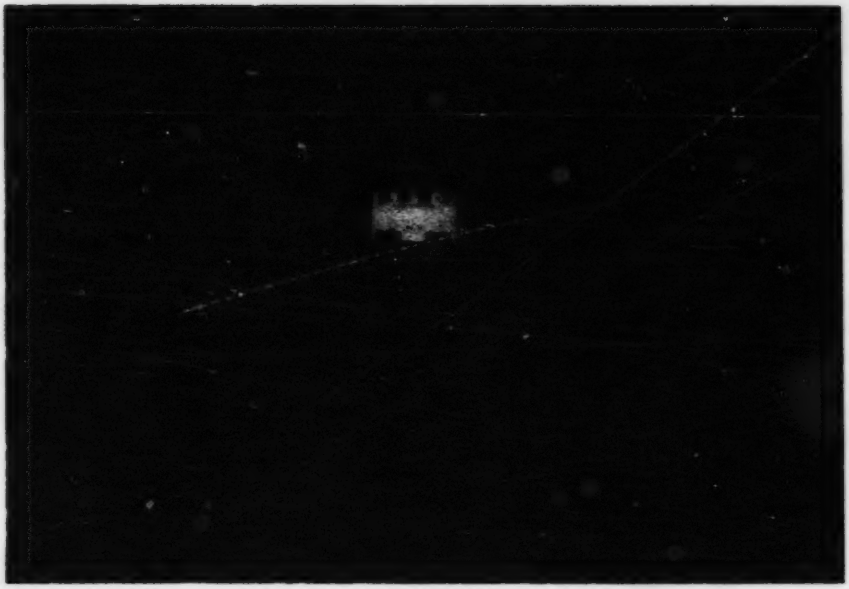

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Photo 3–Feldspar-phyric basalt. Plagioclase laths (oligoclase-andesine) compose 35 percent of the rock.

Feldspar-phyric flows compose an estimated 10 percent of the upper succession and are most prominent near its top. Feldspar laths (oligoclase-andesine) vary from 1 mm to 4 cm in length and constitute 10 to 30 percent of individual flows. Flows containing amygdules constitute an estimated 10 percent of the upper succession, but this relatively low percentage may be due more to preservation than to the actual abundance of amygdules. Amygdules are difficult to recognize and may be mistaken for porphyroblasts or flattened fragments; their composition and preserved roundness in parts of flows serves to distinguish them from other features. Amygdules vary from subrounded to elongate and flattened, are 1 mm to 2 cm long, and are 0.2 to 10 mm wide. They compose from 3 to 15 percent of individual flows, and are filled by carbonate, quartz, magnetite, plagioclase, garnet, pyrite, and chalcopyrite.

The typical mafic volcanic rock of the upper succession is very fine to fine grained and is dark grey to greyish black. The rock is composed of, in order of decreasing abundance; oligoclase-andesine, hornblende and epidote with accessory titanite, magnetite-hematite, quartz, carbonate, biotite, apatite, pyrite, chalcopyrite, and garnet (Table 2). Porphyroblasts of hornblende, garnet, and, not commonly, magnetite are locally abundant.

A thin horizon of *sillimanite-bearing schist* [too small to show on Map 2475, back pocket] is exposed between 2 flows immediately east of the Squaw River, north of Little Bald Lake. The horizon is 2 m thick and is composed of sillimanite, biotite, garnet, carbonate, plagioclase, muscovite, and quartz. This rock was probably a thin layer of volcanic mud formed during a break in volcanism.

Mafic fragmental rocks range from flow breccias, where fragments are similar in composition to the matrix, to finely laminated material containing amygdaloidal and *feldspar-phyric flows* and/or epidote-rich fragments. Laminae vary from 2 mm to 3 cm in thickness, are composed of varying proportions of plagioclase, hornblende, and epidote, and have minor amounts of magnetite-hematite, apatite, titanite, carbonate, and pyrite. Magnetite-hematite porphyroblasts are common. Fragments make up 5 to 15 percent of the rock, many are zoned with feldspar-rich cores and epidote-rich rims, and range from 5 mm to 4 cm in diameter. The fragments are elongate to subangular, and exhibit a subparallel alignment.

Felsic Metavolcanics

Felsic metavolcanics have a colour index less than 15 percent, and are abundant only in the core of the *Squaw River Syncline*. These rocks are exposed from the shores of Pigeon Lake north to Mississagua Lake, a distance of 13 km. At their base, these rocks are interlayered with mafic metavolcanics. In their upper sections, these rocks are interlayered with the rocks of the Upper Metasediments, namely clastic and chemical metasediments, and are intruded by a quartz monzonite to quartz diorite stock.

Fragmental rocks are the most abundant rocks within the felsic metavolcanic succession. The rocks vary from banded types with streaked or swirled matrices to massive deposits containing a wide variety of small rock fragments. Fragments are subangular to subrounded, elongated parallel to the foliation, and compose from 5 to 15 percent, and, uncommonly, as much as 70 percent of the rock unit. These rocks contain fragments composed of; *rhyolite-dacite, feldspar-phyric basalt, amphibolite, hornblende schist, muscovite-pyrite schist, biotite schist*, and quartz monzonite. Rhyolite and dacite fragments form the most abundant constituent of these rocks. Fragments range from 2 mm to 20 mm in diameter and from 3 mm to 16 cm in length. The fragments are particularly noticeable when outlined by magnetite-hematite and/or sulphide grains, and flakes of biotite.

The very fine grained matrix of these pale pink, greyish pink, or light grey rocks is composed of an interlocking mosaic of subhedral-anhedral oligoclase, orthoclase (or microcline), quartz, and biotite with accessory muscovite, magnetite-hematite, carbonate, apatite, pyrite, chalcopyrite, *garnet*, and titanite. Irregular areas of recrystallized, elongate quartz and subhedral microcline, formed principally after orthoclase, may represent relict crystals. Magnetite, and uncommonly, garnet form porphyroblasts throughout the rock. Potassic feldspar is far less abundant than plagioclase feldspar, and typically occurs interstitial to quartz and plagioclase. Quartz varies from less than 5 to 25 percent by volume of these rocks.

These rocks are probably recrystallized and metamorphic equivalents of pyroclastic flow deposits because of the widespread nature of these rocks; their lithological continuity; and the fact that more than 80 percent of fragment types are similar to the matrix.

Felsic flow rocks are relatively uncommon, and are exposed along Highway 36, west of Highway 507, and between this road and the Squaw River. These flow rocks are well banded and very fine grained. Individual bands or layers vary from 1 mm to 3 cm in width and are defined by colour differences due to differences in grain size, and the presence or absence of hematite; and mineralogical changes due to relative percentages of biotite, plagioclase, quartz, and orthoclase.

Fragments where present constitute 5 to 10 percent of a particular flow, are elongate parallel to the banding, and have a composition similar to that of the matrix. Fragments are difficult to see on a fresh surface; they are outlined on the weathered surface by a pinker colour than the enveloping rock and by irregular, elongate areas of material coarser in grain size than the rest of the rock. Fragments are subangular to blocky, and vary from 2 mm to 7 cm in diameter.

Felsic flow rocks are buff to pinkish grey and very fine grained with either a granoblastic or a porphyroblastic texture. These rocks are composed of varying amounts of plagioclase, quartz, potassic feldspar, and biotite with minor amounts of muscovite, hematite-magnetite, apatite, and carbonate. Microcline, biotite, and magnetite-hematite form porphyroblasts which vary from 3 mm to 1 cm in diameter.

Felsic dikes and sills are similar in appearance to flows, but are more massive than flows and are non-fragmental exhibiting sharp contacts with adjacent units. In places, it is extremely difficult to tell if a particular outcrop is a flow, an intrusion, a fragmental pyroclastic flow deposit or a massive flow. Thus, it is possible that more intrusive units exist than have been mapped.

Associated with both flow and fragmental felsic rocks, is a complexly layered, pink and black mottled schist. The layering is well defined and consists of discontinuous lenses, irregular layers, and diffuse swirls of microcline and quartz having traces of plagioclase and biotite which alternate with more continuous and regular layers of biotite, plagioclase, quartz, and muscovite. These rocks are exposed east and west of the Squaw River south of Highway 36, and east of Highway 507 just north of Rockcroft and make excellent marker horizons. Individual bands vary from 5 mm to 2 cm in thickness and in length from 10 mm to 1 m. Biotite-rich bands are commonly folded around microcline-quartz areas or fill fractures in aggregates of microcline and quartz. In places, these rocks are intensely recrystallized and granulated. The origin of these rocks is not known.

Mafic to Felsic Fragmental Rocks

These rocks form distinct fragmental deposits which outcrop south of Highway 36, east and west of the Squaw River, and west of Highway 507. They occur within horizons dominated by mafic and felsic metavolcanics, and are charac-

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Photo 4–Fragments of basalt and dacite-rhyolite in a quartz-biotite-feldspar matrix. Fragments comprise some 70 percent of the rock.

terized by a variety of angular to subrounded clasts which make up 25 to 75 percent of the rock (Photo 4). These rocks vary from matrix- to clast-supported types.

In mafic flows, these rocks contain assorted clasts (3 mm to 20 cm in diameter) of amygdaloidal basalt, feldspar-phyric basalt, hornblende schist, gneissic gabbro, and amphibolite. These clasts are enclosed by a green to greenish grey or dark grey, fine-grained matrix composed of plagioclase, hornblende, carbonate, and epidote with minor amounts of titanite, quartz, magnetite, and apatite. The colour index of such a rock varies from 25 to 40 percent.

One kilometre west of Highway 507, a coarse, poorly sorted to unsorted fragmental deposit grades laterally into and is overlain by, fine-grained bedded metasediments whose composition is similar to the matrix of the underlying breccia (Photo 5). This type of occurrence is particularly common in mudflow-type deposits, and may be one criterion by which such deposits can be recognized in metamorphic terrains.

Felsic fragmental rocks vary, being relatively well-sorted, to coarse-grained and poorly sorted and exhibit a great deal more continuity than the mafic types. The felsic rocks vary from being bedded or well-layered deposits which contain block and lapilli-size fragments, to laminated and massive ash-size material to unsorted deposits having a melange of blocks, lapilli, and ash-

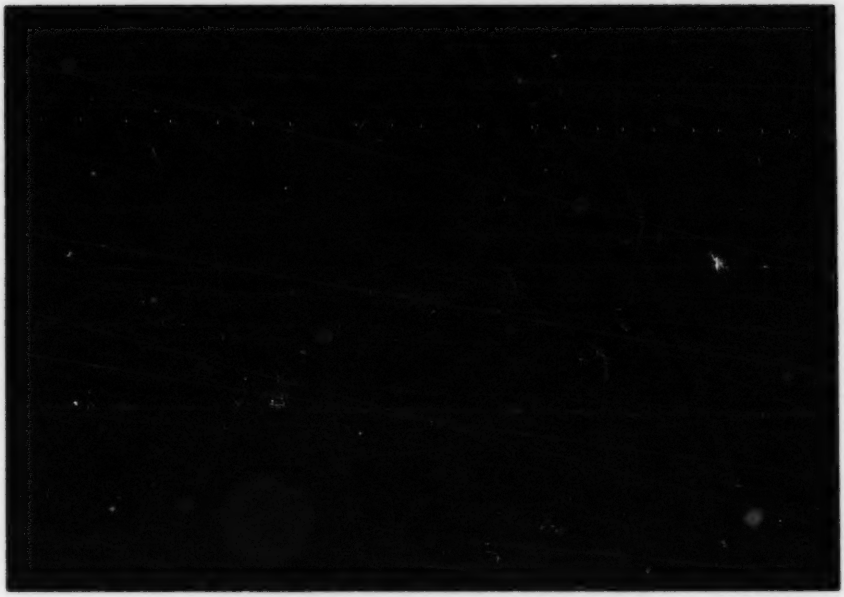

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Photo 5–Finely bedded mafic metasediments overlying a coarse, mafic fragmental deposit.

size fragments. Individual layers or beds vary from 5 cm to 2 m in thickness, and contain 15 to 35 percent fragments. Fragments are subangular to subrounded, exhibit a well-defined parallel alignment, and range in size from 2 mm to 15 cm. The fragments are composed of rhyolite, dacite,quartz monzonite, biotite-quartz schist, quartz-muscovite schist, and amphibolite with minor amounts of feldspar-phyric basalt. Unsorted deposits contain similar fragment types, vary from 3 m to 20 m in thickness; fragments compose from 25 to 70 percent of the deposit.

The matrix for both types of deposits is pale pink to pinkish grey and is very fine grained. It is composed of plagioclase, potassic feldspar, quartz, and biotite with accessory muscovite, carbonate, apatite, and magnetite-hematite which can form porphyroblasts.

METAVOLCANIC ROCK CHEMISTRY

The field and petrographic classification of metavolcanic and associated rocks within Harvey Township was generally substantiated by performing chemical analyses on representative specimens. Twenty-eight samples of rocks considered to be typical of the metavolcanic succession were analyzed by the

TABLE 4 | CHEMICAL ANALYSES OF PRECAMBRIAN ROCKS FROM HARVEY TOWNSHIP.

Map Unit	6	5b	9	5	4	9	4	4b	4	9	4	5b
Sample Number	046	066	091	114	117	118	123	184	186	188	191	194
SiO_2	61.2	64.2	44.1	60.7	44.0	45.6	46.6	49.8	45.5	46.1	43.8	63.5
Al_2O_3	17.3	16.4	13.6	17.4	14.6	15.1	15.6	19.0	14.5	14.5	15.1	16.6
Fe_2O_3	6.07	4.9	14.5	6.72	15.0	15.5	12.9	11.9	16.6	15.3	16.2	5.3
MgO	1.55	0.95	4.5	0.63	6.99	6.27	9.29	4.06	6.00	6.61	8.47	0.75
CaO	2.50	1.86	18.1	1.54	11.4	9.89	11.3	9.99	9.60	10.1	11.5	1.31
Na_2O	7.10	5.84	0.9	6.19	2.82	2.49	1.92	3.16	2.85	1.98	1.75	6.20
K_2O	1.19	3.91	0.12	3.99	0.20	0.30	0.38	0.65	1.13	0.23	0.25	3.71
TiO_2	0.96	0.65	1.85	0.89	2.57	2.66	1.05	1.32	2.18	2.31	1.76	0.38
MnO	0.07	0.14	0.35	0.15	0.23	0.18	0.19	0.18	0.27	0.18	0.26	0.10
P_2O_5	0.32	0.18	0.29	0.22	0.36	0.35	0.09	0.25	0.39	0.21	0.20	0.20
CO_2	0.28	0.50	1.10	0.57	1.43	1.52	0.30	0.49	0.58	0.91	0.20	0.71
L.O.I.	0.50	0.88	0.51	0.60	2.00	2.30	0.90	0.70	1.10	1.10	0.70	0.93
TOTAL	99.0	100.5	99.9	99.6	101.6	102.2	100.5	101.5	100.8	99.9	100.2	99.69

Table 4 - continued

Map Unit	5	6	9	9	5	4	4b	4	5	4b	9a	4	4b	5
Sample Number	003	013	019	023	050	056	072	122	129	161	164	190	007	009
SiO_2	68.5	55.3	57.90	59.1	67.3	45.4	48.5	47.8	64.7	48.1	43.2	47.9	51.3	69.8
Al_2O_3	17.1	17.4	13.40	15.1	14.7	18.4	19.7	13.6	18.0	19.8	14.4	15.2	19.5	16.5
Fe_2O_3	3.59	8.6	15.20	9.11	5.44	12.0	11.0	17.2	4.8	10.0	13.4	14.5	9.55	3.58
MgO	0.25	2.7	1.11	0.78	0.34	4.7	3.72	3.56	0.95	4.89	3.41	5.52	3.22	0.49
CaO	0.61	3.58	1.14	3.55	1.54	12.2	10.4	7.12	1.13	10.8	20.3	11.4	8.66	0.99
Na_2O	5.97	3.83	2.15	6.36	3.94	2.59	3.68	4.51	7.32	3.68	1.14	1.67	3.87	6.39
K_2O	3.34	2.86	5.47	2.13	2.93	1.04	0.51	0.56	1.65	0.87	0.22	0.17	0.56	0.83
TiO_2	0.50	1.44	1.20	1.16	0.37	1.22	1.54	3.13	0.88	1.04	1.69	1.75	1.48	0.57
MnO	0.02	0.10	0.37	0.22	0.14	0.18	0.16	0.22	0.02	0.18	0.31	0.20	0.17	0.20
P_2O_5	0.09	0.51	0.15	0.16	0.04	0.38	0.29	0.31	0.17	0.22	0.26	0.25	0.36	0.09
CO_2	0.11	0.84	0.76	2.01	0.85	1.12	0.08	0.05	0.30	0.09	0.91	0.13	0.93	0.19
L.O.I.	0.30	1.70	0.60	2.10	1.40	0.50	0.60	0.40	0.60	0.40	0.60	0.80	1.30	0.60
TOTAL	100.38	98.9	99.6	101.8	99.0	100.2	98.1	100.5	100.1	99.9	99.9	99.5	100.9	100.2

Footnotes
Chemical analyses performed by Geoscience Laboratories, Ontario Geological Survey, Toronto.
Map Units are shown on Map 2475, back pocket.

Geoscience Research Laboratories, Ontario Geological Survey, Toronto. Averages of the chemical analyses are listed in Table 3. Table 4 lists individual analyses, and sample locations are shown on the geological map of Harvey Township (Map 2475, back pocket).

Examination of the chemical analyses shows that the metavolcanics can be divided into 2 major groups: namely mafic (basalt) and felsic (rhyolite-dacite) metavolcanics. Basalts can be further sub-divided on the presence or absence of plagioclase phenocrysts. Those rocks lacking feldspar phenocrysts are restricted to the basal two-thirds of the mafic succession and can be classified as tholeiite and olivine tholeiite. Some of these basalts are nepheline normative, apparently a result of secondary sodium enrichment rather than primary silica undersaturation. This lower succession is characterized by high total iron (as Fe_2O_3); relatively low SiO_2, compared to feldspar-phyric basalt, high TiO_2; low K_2O; and average amounts of aluminum (*see* Table 3).

Feldspar-phyric basalts are found only in the upper one-third of the basalt succession, and are mineralogically different from other basalts in the area because they contain more plagioclase and less hornblende. The average colour index of feldspar-phyric basalts is 30 compared to 44 for the lower basalts. Compared to the more mafic basalts, these rocks have greater amounts of SiO_2 and Al_2O_3 and lesser quantities of iron (as Fe_2O_3), TiO_2, and MgO (*see* Table 3).

Parts of these rocks approach an ultramafic composition and are probably small sills and/or dikes. Other mafic rocks occurring as sills are characterized by high CaO (19 percent), low MgO (4 percent), and low SiO_2 (43 percent). The origin and relationship of these rocks to the basalts is not clearly understood. Gabbro dikes and sills are chemically similar to the basalts in the lower two-thirds of the succession.

Felsic metavolcanics are silica-rich with low MgO and high iron (*see* Table 3). Sodium is in all samples greater than 4 percent. Potassium varies from 1 to 4 percent and titanium is relatively high, averaging 0.6 percent. These rocks are classified as felsic tholeiites and thus represent the differentiated upper part of the basalt succession.

The felsic rocks containing abundant fragments are chemically distinct from the felsic rocks containing few fragments; silica is lower and iron, magnesium, and titanium values are higher (*see* Table 3). These differences are believed to be due to the presence of small basalt fragments which could not be separated from the matrix before chemical analyses were performed.

The quartz monzonite-quartz diorite intrusion which occupies the core of the *major syncline* [not shown on Map 2475, back pocket] in the area contains less silica, more iron, potassium, and titanium (*see* Table 3) than the surrounding felsic metavolcanics. These differences could be due to alteration which appears to be widespread within the stock, or the stock could represent one of the earliest phases of felsic magmatism.

Upper Metasediments

CHEMICAL METASEDIMENTS

Rocks mapped as chemical metasediments are composed of the following: muscovite-quartz-pyrite schist, bedded quartz-rich tuff, chert, feldspar-biotite schist and gneiss and *calcite-quartz* schist. Typically, these rocks occur together and have been mapped as a single unit which can be traced along strike for a distance of 1.2 km. These rocks are exposed south of Highway 36 both east and west of the Squaw River, and between Sandy Lake and Little Bald Lake and occur close to the top of the volcanic succession. Such rocks are spatially associated with felsic flow and fragmental rocks, feldspar-phyric and amygdaloidal flows, and/or epiclastic metasediments. Invariably, quartz monzonite and quartz diorite sills and dikes are exposed nearby.

These metasediments vary from being massive to well layered and finely laminated types. Muscovite-quartz-pyrite schist, calcite-quartz schist, and feldspar-biotite schist and quartz-biotite gneiss are the most abundant rock types. They are fine-grained, well foliated, brownish grey, locally weather to a "gossan", and are poorly exposed.

Muscovite-quartz-pyrite schists are typically composed of varying amounts of quartz, muscovite, calcite, pyrite, and plagioclase; minor amounts of biotite, *garnet*, potassic feldspar, epidote, phlogopite, chalcopyrite, magnetite-hematite, sphalerite, and apatite are also present. The biotite-rich schist and gneiss are coarse grained and are composed of plagioclase, biotite, quartz, and potassic feldspar; minor amounts of muscovite, calcite, garnet, epidote, magnetite-hematite, and pyrite are also present.

Quartz-rich tuff, and chert are fine grained, flinty grey rocks composed of quartz (more than 40 percent) carbonate, plagioclase, biotite, potassic feldspar, and muscovite. These rocks typically contain up to 3 to 4 percent disseminated pyrite.

South of Little Bald Lake, a bedded quartz-rich tuff or chert grades laterally into a rock composed of calcite (70 percent), quartz (15 percent), hornblende (10 percent), and epidote (5 percent). This rock could represent the carbonate part of a quartz-carbonate ironstone formation.

Thin units of felsic metavolcanics and feldspar-phyric flows and amphibolite are interlayered with these metasediments, Unit 7a, and indicate that the chemical metasediments were deposited while volcanism was still in progress. The mineralogy, rock associations, and stratigraphic position indicate that they most likely represent a series of chemically precipitated tuffs, and volcanic muds which were deposited in small shallow basins during the waning stages of felsic volcanism.

Clastic Metasediments

SILLIMANITE-BEARING SCHIST

Dark grey to grey, fine- to medium-grained sillimanite-bearing schists constitute thin beds or thick lenses within the upper chemical metasediments and the mafic metavolcanics respectively. These rocks are most abundant west of the Squaw River between Little Bald Lake and Highway 36, and immediately north of Sandy Lake.

Beds and layers range from 1 to 5 m in thickness, and have a maximum uninterrupted thickness of 80 m. These layers form relatively sharp contacts with adjacent rock units and can be traced for a maximum distance of 0.4 km. The rocks are composed of sillimanite and garnet porphyroblasts, 3 mm to 10 cm in size set in a finer grained matrix composed of sillimanite, plagioclase, quartz, biotite, muscovite, tourmaline, and microcline. The rocks are poorly exposed, and are believed to represent either pelitic horizons within volcanically derived epiclastic rocks, or more rarely, are fine muds deposited on basalt flows during periods of quiescence.

BIOTITE SCHIST AND GNEISS

Epiclastic rocks which have a similar mineralogy to felsic metavolcanics, form a relatively thick succession west of the Squaw River between the Bald Lake Narrows and Highway 36, and immediately south of the Bald Lake Narrows.

These metasediments comprise biotite and muscovite schist, and gneiss and quartz-plagioclase-biotite schist and gneiss, and grade into less intensely deformed but minor wacke, siltstone, and conglomerate. The rocks are poorly to well bedded, fine to medium grained, and contain from 5 to 15 percent clasts of felsic and mafic volcanic rocks as well as muscovite-quartz schist, hornblendite, and gneissic gabbro.

For descriptive purposes, these rocks can be divided into 2 groups:

1. Biotite-poor schists and gneisses which are composed of plagioclase, orthoclase, and quartz with minor biotite (<10 percent), muscovite, carbonate, titanite, apatite, pyrite and magnetite-hematite.
2. Biotite-rich schists which are composed of plagioclase, biotite (20 to 30 percent), and quartz with accessory potassic feldspar, muscovite, carbonate, titanite, apatite, magnetite-hematite, and garnet. Garnet and biotite porphyroblasts are locally abundant, magnetite porphyroblasts appear to be absent, and in places large, irregular grains of quartz and plagioclase (4 mm to 2 cm) are set in a fine-grained matrix composed of quartz, carbonate, biotite, and plagioclase. The large crystals of quartz and feldspar are elongated parallel to the primary layering, and plagioclase exhibits relict twins which abut against broken grain boundaries.

Conglomerate forms narrow lenses 2 m to 20 m long within quartz-feldspar wacke. This conglomerate contains 10 to 25 percent pebbles and cobbles of felsic and mafic basalt, biotite schist, and gneissic gabbro. Pebbles are subrounded to subangular, elongated parallel to the major foliation direction, and are set in a matrix composed of quartz, plagioclase, and biotite.

Rocks of this unit are an integral part of the volcanic succession, and are characterized by numerous volcanically derived clasts, the lack of granitic clasts, a similar mineralogy to that of the adjacent metavolcanics, an interlayering with felsic metavolcanic material, and a spatial association with the mafic to felsic fragmental rocks. These rocks should not be confused with the clastic metasediments of the lower metasedimentary unit. These clastic metasediments are

1. Associated with, and grade into, marbles and banded gneiss;
2. Lack any evidence of volcanically derived material;
3. Contain abundant magnetite-hematite porphyroblasts, and lack titanite as an accessory mineral;
4. Do contain minor amounts of staurolite.

METAMORPHOSED INTERMEDIATE TO MAFIC INTRUSIVE ROCKS

MAFIC AND ULTRAMAFIC INTRUSIONS

Dikes and sills of gneissic gabbro, hornblendite, and *metaperidotite(?)* are found in basalt, being particularly common in the lower part of the volcanic succession. A few gabbroic dikes are intrusive into felsic metavolcanics. Mafic intrusive rocks also occur as xenoliths in flows low in the succession and as fragments in the felsic metavolcanics.

The mafic intrusive rocks have a similar mineralogy to mafic basalts except for the metaperidotite(?) sill which contains abundant anthophyllite and cummingtonite. The textures of the rocks vary from medium grained and granoblastic to coarse grained and clotty. The rocks are augen schists modified after textures of a coarse gabbro. These rocks contain hornblende porphyroblasts which are enclosed by a fine-grained matrix of plagioclase and hornblende. Minor ironstone is associated with gneissic gabbro east of Highway 506 between this road and Mississagua Lake.

The stratigraphic position and mineralogy of these intrusive rocks suggest that they are subvolcanic intrusions and cumulates derived from basaltic magmatism.

QUARTZ MONZONITE AND QUARTZ DIORITE INTRUSIONS

Numerous quartz monzonite, dikes and sills occur throughout the volcanic succession. A quartz monzonite to quartz diorite stock forms the core of the *Squaw River Syncline*. The stock is well foliated, elongate in a north-northeast-

erly direction, and is 1.5 by 3 km in size. It is intrusive into the upper part of the volcanic succession, but is, itself, intruded by rhyolite-dacite dikes and occurs as fragments in a flow breccia immediately north of Highway 36.

Contacts between the stock and adjacent metavolcanics vary from being sharp to gradational. These contacts are accompanied by areas of intrusive breccia. The areas of intrusive breccia range from 20 to 70 m in length and 15 to 40 m in width, and are composed of fine-grained quartz diorite, and, not commonly, quartz monzonite which cements fragments (1 cm to 3 m) of various metavolcanic and epiclastic rocks.

Typically, quartz monzonite and quartz diorite are mottled grey and black or are pinkish grey, fine- to medium-grained granoblastic rocks having a colour index of 15 to 30 percent. These rocks are composed of oligoclase, potassic feldspar, quartz, and biotite with accessory amounts of hornblende, apatite, titanite, carbonate, magnetite, pyrite, chalcopyrite, bornite, molybdenite, apatite, and garnet. Locally, hornblende and garnet form porphyroblasts. Biotite, garnet, carbonate, and opaque minerals form clusters 2 mm to 1.5 cm or knots of crystals which exhibit amphibole outlines. Along Highway 36, east and west of the Squaw River, quartz monzonite contains large 14 mm to 3 cm clots of magnetite, hornblende-magnetite, or biotite- hornblende-magnetite. These minerals compose up to 30 percent of the rock and give the outcrop a dotted or speckled appearance.

North of Highway 36, quartz monzonite has been intensely fractured and the 1 mm to 2 cm wide fractures are sealed by quartz, magnetite, pyrite, plagioclase, chalcopyrite, and molybdenite. "Anomalous" uranium values are also associated with these zones.

Dikes and sills of quartz monzonite, and not commonly, monzonite, are found throughout the volcanic succession. These dikes and sills are 10 cm to 6 m wide bodies, form sharp contacts with adjacent rocks, and are composed of plagioclase, potassic feldspar, biotite with or without quartz, apatite, titanite, magnetite, and pyrite.

METAMORPHOSED INTERMEDIATE INTRUSIVE ROCKS

The volcanic succession has been intruded by a pluton composed of granodiorite and quartz diorite underlying a 30 km^2 area which extends from Highway 36 northwards to Lavery and Spinster Lakes. This pluton contains numerous metavolcanic and quartz monzonite fragments near its eastern border and has, itself, been intruded by, now metamorphosed, felsic intrusive rocks. In places, the contact between metamorphosed felsic and intermediate intrusive rocks, marked by a narrow zone 5 to 10 m wide, is sheared and granulated.

Typically grey, blackish grey, or mottled black and grey, granodiorite possesses a lenticular foliation defined by biotite, magnetite, and deformed mafic inclusions, and a crenulation cleavage defined by biotite porphyroblasts and quartz aggregates which occur at an angle of 15 to 30° to the main foliation direction. A lineation is also defined by biotite flakes and quartz spindles which are typically 0.5 to 1.5 cm long. Layering and other persistent inhomogeneities are noticeable by their absence.

Granodiorite is a fine- to medium-grained, essentially granoblastic rock which exhibits some relict igneous textures in thin section. The rock consists of oligoclase-andesine, quartz, potassic feldspar, and biotite or hornblende with accessory amounts of magnetite and apatite. The colour index varies from 15 to 25 percent. An increase in the percentage of hornblende and a corresponding decrease in biotite occurs from south to north along the strike of the pluton.

The pluton becomes finer grained within 5 to 15 m of its contact with the metavolcanics. In this zone, lenticular inclusions of amphibolite and/or plagioclase-quartz-potassic feldspar gneiss 1 to 3 m in diameter are common. Within the metavolcanics, a few sills and/or transposed dikes up to 3 m wide of granodiorite occur. These are generally concordant with the foliation, but locally cut across layering.

The granodiorite is intruded by medium-grained, weakly foliated granite and granodiorite, aplitic dikes and veins,and by granite pegmatite dikes. Irregularly folded quartz and quartz-microcline veins are locally developed in the rock.

METAMORPHOSED FELSIC INTRUSIVE ROCKS

Finely banded to massive granite, granodiorite, and peristerite-bearing granodiorite form numerous dikes, sills, and larger, more irregular plutonic bodies. The rocks are intrusive into all the other Precambrian rocks of Harvey Township except for pegmatites and late diabase dikes and sills.

These intrusive rocks are most abundant in the Burleigh Gneiss Complex and can in many places commonly form up to 50 percent of the outcrops of banded gneiss and migmatite. These rocks also form elongate north-northeasterly trending bodies which underlie some 25 km^2 in the west-central part of the township. Here, these rocks are intrusive into metavolcanics and the metamorphosed intermediate intrusive rocks.

The rocks are salmon pink or pinkish grey, medium to coarse grained, and have a colour index of 1 to 15 percent.They are commonly massive, but are locally weakly foliated. The foliation is defined by the subparallel alignment of biotite and magnetite.

Thin section examination reveals these rocks to be granoblastic, but can exhibit igneous textures. The rocks are composed of oligoclase, potassic feldspar, and quartz with minor amounts of biotite, magnetite, chlorite (after biotite), zircon, and muscovite. Magnetite and/or hematite commonly form porphyroblasts.

Peristerite-bearing granitic rocks are exposed west of Highway 506 near the northern boundary of the map area. They are similar in composition to the rocks just described, but peristerite forms large porphyroblasts (4 mm to 4 cm) which compose from 5 to 20 percent of the rock.

Aplitic granite forms an elongate body (3.2 by 1.3 km) east of Nogies Creek near the northern boundary of the map area, and numerous dikes within the metamorphosed felsic intrusive rocks. The aplite is fine grained, "sugary" textured, buff to cream, and is composed of plagioclase, potassic feldspar and quartz. Magnetite porphyroblasts are locally present in trace amounts.

LATE FELSIC INTRUSIVE ROCKS

Dikes and sills of pegmatitic granite and granodiorite are common throughout the map area, and are most abundant within the Burleigh Gneiss Complex. These rocks are intrusive into all of the previously described Precambrian rocks and typically form sharp contacts. Xenoliths of adjacent rock types are present. Rarely are these rocks gradational into massive, medium-grained granite and/or gneissic granodiorite.

Pegmatite dikes and sills vary from 5 cm to 7 m in width, and are generally massive and undeformed, but locally have been isoclinally folded with adjacent rock types. These rocks are pink, pinkish grey, and cream. Three distinct types exist:

1. The most abundant type is composed of potassic feldspar (40 percent), quartz (25 percent), albite-oligoclase (25 percent), and biotite (5-10 percent) with accessory amounts of apatite, magnetite, hematite, and pyrite. These rocks exhibit good igneous textures, and are randomly distributed throughout the map area.
2. Pegmatite dikes and sills of this type are composed of subhedral crystals of pink microcline (2 to 6 cm) set in a finer grained matrix (1 to 2 cm) of microcline (35 percent), quartz (25 percent), and plagioclase (25 percent) with accessory amounts of magnetite, tourmaline, apatite, biotite, zircon, hornblende, pyrite, and chalcopyrite. Graphic intergrowths of microcline and quartz are common, and biotite exhibits pleochroic halos. Most of the known uranium occurrences in Harvey Township are associated with these rocks.
3. Pegmatites of this type are relatively uncommon being composed of a green feldspar (amazonite) with quartz, potassic feldspar, biotite, and accessory magnetite, pyrite, and apatite. Only 4 occurrences of this type were observed, and all are located in the Burleigh Gneiss Complex.

MAFIC INTRUSIVE ROCKS

Though not abundant, diabase dikes and sills intrude all of the intrusive rocks of Harvey Township. These late intrusions vary from 2 to 7 m in width, form sharp contacts with adjacent units, and are blackish green to blackish grey, fine- to medium-grained rocks. They exhibit good igneous textures and are composed of andesine, and hornblende with lesser amounts of epidote, magnetite, and quartz. Ophitic textures are locally preserved in these rocks.

Paleozoic

ORDOVICIAN

The Paleozoic rocks are of Ordovician age (Liberty 1969), and can be divided into two distinct units.

The lower unit unconformably overlies Precambrian rocks, and is composed of polymictic conglomerate, sandy shale, and lithic wacke. Pebbles and cobbles of pegmatitic granite, massive, medium-grained granite, and granodiorite occur in the conglomerate as well as large subrounded grains of quartz, microcline, and plagioclase. The matrix of conglomerate and lithic wacke is composed of quartz, carbonate, plagioclase, and biotite.

The upper and by far the most abundant unit varies in composition from massive to fossiliferous limestone and limestone breccia to thin, interbeds of calcareous shale. For a more detailed description of these rocks the reader is referred to Liberty (1969).

Cenozoic

QUATERNARY

Pleistocene

Glacial till in ground moraine deposits is commonly gravelly to sandy, containing numerous pebbles and boulders derived from Precambrian rocks. Throughout most of the map area, the ground moraine is not more than a few metres thick, though thicker accumulations occur in valleys or between prominent rock ridges.

Numerous small deposits of sand and gravel overlie, and in places are interstratified with, ground moraine material. These deposits are locally bedded, and are found at the edges of lakes, swampy areas, or along stream valleys. They have been used extensively for construction of local roads.

The thickest and most extensive Pleistocene sand and gravel deposits occur in a belt extending south from Mississagua Lake across the area in the vicinity of Highway 507 to Buckhorn. These deposits appear to represent an ancient river channel and outwash system which possibly constituted the main drainage course for Mississagua Lake and the Mississagua River in postglacial times.

SUMMARY OF GEOLOGICAL HISTORY

The deposition of shale, sandstone, and minor conglomerate of the lower metasediments and Burleigh Gneiss Group constituted the earliest event. These rocks are dominantly composed of quartz, plagioclase, and potassic feldspar. The sedimentary basin in which these rocks were deposited gradually subsided. Clastic sedimentation gave way to the chemical precipitation of carbonates.

A period of uplift and erosion was followed by the extrusion of a relatively thick succession of dominantly tholeiitic basalts. A broad plateau or plain composed of numerous, thin, massive, and amygdaloidal flows grading upwards into less mafic feldspar-phyric flows was formed. This was followed by the eruption of both basalt and dacite probably from the same vents and/or fissures. Mixed volcanism gradually gave way to dominantly felsic material which formed pyroclastic flow deposits, mudflow breccias, and smaller volumes of lava flows, pyroclastic deposits, and dikes, sills, and stocks. In the waning stages of volcanism, hot spring activity supplied the necessary elements which led to the local formation of the chemical sediments of the Upper Metasediment Group. At about the same time, erosion of the volcanic terrain was taking place, and this epiclastic material was deposited in small basins to form the clastic metasediments of the Upper Metasediment Group.

After volcanism had ceased, a granodiorite pluton was intruded into the upper parts of the volcanic succession. After this event, the terrain was subjected to pervasive deformation about northeasterly trending, variously plunging axes, and was subjected to progressive regional metamorphism. Peak temperatures, which increased from west to east, were imposed after the first folding event and caused local melting and anatexis. These anatectic melts formed the migmatite in the Burleigh Gneiss Complex. As metamorphism and deformation progressed, mobilization of the melts took place and these were injected as granite and granodiorite dikes, sills, and plutons within sedimentary and volcanic rocks. Pegmatite dikes and sills were then emplaced.

Diabase dikes and sills represent the last intrusive episode in the area and this took place during the waning stages of metamorphism.

The terrain was then uplifted and the supracrustal rocks were partly removed by erosion. Subsidence during the Ordovician resulted in the deposition of limestone over the area. Subsequent uplift and erosion has removed a great deal of these Ordovician deposits.

Pleistocene glaciation modified drainage and topography and left a mantle of unconsolidated deposits over the region.

STRUCTURAL GEOLOGY

The metavolcanics and metasediments are complexly folded, particularly in the south-central, north-central, and northwestern parts of the township. The principal fold pattern developed before the culmination of regional meta-

morphism. This is indicated by the occurrence of randomly orientated porphyroblasts in the metasediments and metavolcanics. A second episode of deformation which may have developed during the formation and emplacement of the Burleigh Gneiss Complex, has folded original surfaces (schistosity and flattened clasts) throughout the area. These are particularly well developed near the Burleigh Gneiss Complex. The main fold axes trend northeast; small folds have a variable plunge.

Metavolcanics and the underlying metasediments and marbles north of Sandy Lake, face westerly away from the Burleigh Gneiss Complex. Mafic metavolcanics overlying banded gneiss in the northeastern part of the map area face westerly away from Mississagua Lake. Mafic metavolcanics west of the Squaw River face easterly. The metavolcanics and associated sedimentary rocks thus lie in a broad, northeasterly-trending syncline, which closes southwards and is bounded to the east by the Burleigh Gneiss Complex. The relationships of these rocks in the west are obscured by overburden. The Burleigh Gneiss Complex is a broad, antiformal structure. The orientation of schistosity within the complex changes from near vertical at its western edge, to shallow in its south-central parts.

Schistosity and foliation in metavolcanics and metasediments parallel the axial trace of the major syncline [not shown on Map 2475, back pocket]. Fragments and amygdules in metavolcanics, and clasts in metasediments provide good strain markers. These show flattening and elongation. The degree of elongation appears to increase from the central part of the area to the north and south.

Crenulation cleavage and kink bands within the metamorphosed intermediate intrusive rocks appear to represent an additional phase of deformation.

Several lineaments, which are readily apparent on air photographs and are shown on the Map 2475, back pocket, are probably faults because they coincide with one or all of the following features:

1. zones of shearing and granulation
2. transposition of foliation
3. steepsided hills

Within the Burleigh Gneiss Complex, two major systems of faults are observable: a northeast system and a northwest system. These systems possibly represent conjugate faults. Most of the faults which were recognized appear to be subvertical.

METAMORPHISM

One major metamorphic event is recorded, more may have occurred in the Precambrian rocks of Harvey Township. Any textural relicts are either of igneous or of sedimentary origin, or are "upgraded" pseudomorphs related to the establishment of the present metamorphic assemblages. The grade of metamorphism is generally consistent throughout most of the map area.

Within pelitic rocks associated with the metavolcanic succession, the assemblage sillimanite-plagioclase-muscovite-garnet-biotite is stable. This as

semblage is typical of the sillimanite-almandine-muscovite subfacies of the almandine-amphibolite facies of metamorphism. Mafic metavolcanics contain hornblende and plagioclase (oligoclase-andesine) throughout the area; chlorite, chloritoid, and diopside are absent.

Rocks within the banded gneiss unit of the Burleigh Gneiss Complex contain biotite, staurolite, and garnet. The grain size of these minerals increases and relict textures are increasingly obliterated as the migmatite complex is approached.

The metamorphic rocks are assigned to an intermediate-pressure facies series because of the presence of sillimanite and staurolite and the absence of andalusite and cordierite in the map area. The migmatites indicate that temperature highs or areas of water saturation where H_2O-O_2 fugacities were high, resulted in partial melting.

ECONOMIC GEOLOGY

Harvey Township has little history of mineral exploration, and has no documented metal production. As with other townships in the Grenville Province, prospecting for gold occurred in the late 19th Century and early 20th Century, but has been negligible since 1920. In the mid 1950s, the township underwent its greatest period of exploration with the discovery of uranium-bearing pegmatite dikes in the Bancroft area. Deposits located within Harvey Township turned out to be too small or were of too low a grade to be economically viable at that time. As demand for uranium in the late 1950s decreased, all exploration for uranium ceased in the township. From 1975 to 1977, exploration companies have re-evaluated deposits within Harvey Township, and have explored for new, economic sources of uranium.

Base-metal exploration in the area has been virtually non-existent since 1920. During the current field program, zones containing disseminations and streaks of pyrite and pyrrhotite with minor chalcopyrite and sphalerite were discovered within the felsic metavolcanic and associated sedimentary rocks. Also minor quantities of molybdenite, chalcopyrite, bornite, and pyrite were located within a small quartz monzonite intrusion or were located adjacent to it.

Small deposits of marl occur in the northwestern part of the township. Sand and gravel deposits throughout the area have been utilized for local road construction.

Locations of known uranium deposits and marl concentrations are shown on Map 2475, back pocket. Small base-metal occurrences are marked by the appropriate symbols.

Base-Metal Mineralization

COPPER IN FELSIC METAVOLCANICS

Minor quantities of chalcopyrite with pyrite, magnetite, and/or specular hematite are found at several localities in massive, finely banded and/or lapilli-sized fragmental felsic metavolcanics north of Pigeon Lake and west of Highway 507. Sulphide minerals occur as disseminations, rims around and/or replacements of mafic fragments, and as narrow stringers which vary from 1 to 8 per square decimetre. Pyrite is estimated to be the most abundant sulphide (0.1 to 3 percent by volume) followed by chalcopyrite (less than 0.1 to 0.5 percent) with traces of sphalerite. Associated minerals are magnetite (up to 3 percent by volume), specular hematite, potassic feldspar, quartz, biotite, epidote, and muscovite. These minerals are concentrated in stringers with sulphide minerals, or are found as distinct, irregular patches (5 mm to 2 m in width) throughout rocks containing disseminated sulphide minerals.

Associated volcanic rocks are fine grained, have a colour index of less than 15 percent, and in many places contain angular and elongate flattened fragments of biotite schist, amphibolite, hornblendite, quartz-feldspar-muscovite gneiss, and quartz-muscovite schist. Fragments vary from less than 1 mm to 7 cm in diameter, and compose 15 to 60 percent of the rock. These are particularly noticeable when outlined by small sulphide grains. Fragments are enclosed in a pink to pale grey, fine-grained matrix composed of quartz, potassic feldspar, albite-oligoclase, and muscovite with accessory biotite, apatite, titanite, magnetite, and/or specular hematite. Magnetite, specular hematite, and potassic feldspar form porphyroblasts throughout the rock. Banded rocks have a similar composition; 1 to 3 mm wide layers or lenses of quartz, potassic feldspar, albite, muscovite, and magnetite alternate with biotite, oligoclase, and magnetite.

Sulphide zones are discontinuous and irregular with a strike length which varies for 1 to 20 m. Bands and stringers of sulphide minerals parallel the major foliation direction and exhibit evidence of deformation. Sulphide-bearing felsic metavolcanics occur in many places adjacent to feldspar-phyric basalts or near the top of a succession of felsic flows, tuffs, and related sedimentary rocks.

COPPER IN MAFIC METAVOLCANICS

Minor quantities of pyrite and chalcopyrite are found as disseminations and amygdaloidal fillings within mafic flows. Arsenopyrite and magnetite occur in trace amounts, whereas pyrite varies from less than 0.1 to 3 percent by volume. Associated minerals are calcite, epidote, quartz, actinolite, and garnet, with or without biotite, specular hematite, and zoisite.

Sulphide-rich areas vary from clusters of irregular grains 1 to 6 mm in width to areas 5 m wide and 3 to 15 m long. These latter zones commonly traverse flow contacts before being confined to a flow-tuff or flow-flow contact zone. This type of sulphide occurrence was observed south of Pigeon Lake (lot 15, con-

cession XI, Harvey Township, and lot 14, concession XII, Harvey Township), west of Nogies Creek (lot 31, concession XVI, Harvey Township), and east of the Squaw River (lot 27, concession XI, Harvey Township).

COPPER IN RUSTY-WEATHERING SCHISTS AND GNEISSES

Most of the sulphide minerals found within the metavolcanic succession occur in a series of rocks composed of the following: muscovite-quartz schist, *sillimanite-quartz schist* [not in map legend], bedded quartz-rich metatuff, chert, feldspar-biotite schist, quartz-biotite gneiss, and calcite-quartz schist. Typically, these rocks occur together, and, except for the sillimanite-bearing rocks, have been mapped as a single unit (Unit 6a, Map 2475, back pocket). These rocks are found south of Highway 36 east and west of the Squaw River and south of Pigeon Lake. These rocks are close to the top of the volcanic succession, and are spatially associated with felsic flows, coarse-grained fragmental rocks, feldspar-phyric basalts, and/or bedded epiclastic sedimentary rocks. Quartz monzonite and quartz porphyry sills and dikes are exposed near to these rocks.

Sulphide-bearing schists and gneisses are fine grained with sulphide minerals found as disseminations, blebs (1 to 4 mm in size), irregular streaks (3 mm to 9 cm long), and narrow stringers (1 to 10 per square decimetre) which generally parallel the major foliation direction and exhibit evidence of more than one phase of deformation. These types of occurrences are found on lots 17 and 18, concessions XII and XIII, Harvey Township, and on lots 14 and 15, concession XII, Harvey Township. The schists and gneisses contain quartz and muscovite as major constituents and talc, feldspar, biotite (phlogopite?), calcite, ankerite(?), magnetite, sillimanite, garnet, and actinolite are minor components. Pyrite is the most abundant sulphide mineral varying from less than 0.1 to approximately 6 percent by volume; chalcopyrite is present in minor quantities (less than 0.1 to 0.5 percent) and sphalerite and galena are uncommon constituents.

Narrow stringers 1 mm to 2 cm in width and irregular, streaky bodies of massive pyrite with minor pyrrhotite are present in some muscovite-quartz-pyrite schist and bedded metatuff units (lot 19, concession XII, Harvey Township), particularly where these are overlain by metachert and/or carbonate-quartz schist. Sulphide lenses vary from 1 to 3 m in length and 4 to 25 cm in width, and commonly exhibit evidence of fracturing and folding.

The origin of these rocks is not known. The mineralogy, rock associations, textures, and stratigraphic position indicate that these rocks are most probably to have been a related series of chemically precipitated rocks, tuffs, and volcanic muds which formed near and/or at the surface during the waning stages of a cycle of mafic-felsic volcanism.

COPPER AND MOLYBDENITE IN METAMORPHOSED INTRUSIVE ROCKS

Small showings of chalcopyrite and molybdenite with pyrite and traces of bornite have been located within a quartz monzonite to quartz diorite stock which is situated north and south of Highway 36 along the Squaw River. The sulphide occurrences can be classified into three distinct types:

1. Chalcopyrite, pyrite, and magnetite with or without bornite and molybdenite in quartz-magnetite breccias close to the centre of the stock. The breccias consist of numerous stringers, veins, and open space fillings which surround and seal small fragments to large blocks of medium-grained quartz monzonite.

   Veins, stringers, and open space fillings are divisible into 2 distinct types based on mineralogy and texture. The oldest is composed dominantly of fine-grained magnetite (2 to 10 percent) and quartz (30 to 50 percent) with lesser amounts of coarse-grained biotite,feldspar, and pyrite. The second type cross-cuts type one and is composed of quartz (50 to 70 percent) with minor amounts of magnetite, pyrite, chalcopyrite, muscovite, feldspar, and apatite. The most abundant sulphide mineral is pyrite (0.1 to 3 percent) followed by chalcopyrite (less than 0.1 to 0.3 percent) and trace amounts of bornite and molybdenite.

   The breccia zones vary from 10 to 70 m in width and 20 to 150 m in length, and exhibit elliptical outlines whose long axes parallel the north-northeast elongation of the stock. Stringers and veins range in density from 4 to 30 per square decimetre and from 1 mm to 4 cm in width. A weakly radioactive anomaly is associated with one of these breccia zones (Imperial Occurrence (5)[1]; *see* Map 2475, back pocket).

2. Chalcopyrite, molybdenite, and pyrite associated with quartz, potassic feldspar, and biotite in stringers along the outer margins of the stock. Stringers vary from 1 mm to 1 cm in width, range from 2 to 10 per square decimetre and seal fractures within zones of intrusive breccia. The intrusive breccia is composed of fine-grained quartz monzonite or quartz diorite which cements fragments (1 cm to 4 m) of various metavolcanic and epiclastic rocks. Breccia zones range from 10 to 30 m in width and 20 to 70 m in length. Sulphide minerals are sparsely distributed within these zones.

3. Molybdenite, pyrite, and minor magnetite spatially associated with grey-pink calcite which seals fractures within zones of intense shearing. Shear zones are relatively rare, vary from 1 to 15 m in width, and are filled by a variety of secondary vein material with only calcite-bearing members containing sulphide minerals. The sulphide minerals are sparsely distributed with flakes and rosettes of molybdenite up to 1.5 cm in diameter and cubes of pyrite set in a mixture of fine to coarsely crystalline calcite with traces of quartz and magnetite.

[1]The property number in parentheses is shown and listed on Map 2475, back pocket.

IRON

Two thin bands of iron formation, each spatially associated with gneissic gabbro, hornblendite, and metaperidotite(?), have been found within the map area. The thickest unit (1 to 3 m) is situated midway between Highway 507 and Mississagua Lake and is composed of a fine-grained aggregate of magnetite and quartz with minor quantities of carbonate and pyrrhotite. This unit stratigraphically overlies a fine-grained mafic rock composed of hornblende, actinolite, talc, magnetite, and garnet; this unit is 7 m thick and has been interpreted to be a metaperidotite. The iron formation and metaperidotite(?) form the core zone of a small, isoclinally folded, southwesterly plunging anticline. The second occurrence is situated southwest of Highway 507 and the Squaw River. It is nearly identical in composition to the above-described iron formation, is less than 1 m thick, and is found at 2 small outcrops which are associated with hornblendite and gneissic gabbro.

URANIUM

There are 5 known deposits of uranium within Harvey Township; 4 were discovered in the late 1950s (Satterly 1956) whereas the fifth was located by Imperial Oil Limited in 1975. With the possible exception of the Imperial Occurrence (5), all of the known deposits are associated with leucocratic dikes and sills of late pegmatitic granite which are intrusive into the metasediments. Large numbers of these intrusions are found throughout Harvey Township; all exhibit weakly radioactive anomalies, but thus far, only 4 have warranted further exploration work.

Uranium-bearing granitic intrusions vary in composition, but are invariably bimodal with large crystals of microcline (2 to 4 cm) set in a finer grained matrix (1 to 2 cm) of microcline, clear smokey quartz, magnetite, and albite with lesser quantities of tourmaline, apatite, biotite, zircon, and hornblende. Small quantities of pyrite and chalcopyrite may also be present. Uranium-bearing minerals, principally uranothorite and uraninite (Satterly 1956), occur either as disseminations associated with coarse magnetite and aggregates of smokey quartz, or in stringers with quartz, microcline, magnetite, and apatite. Here graphic intergrowths of quartz and potassic feldspar are not uncommon.

Dikes and sills vary from 0.5 to 6 m in width with known strike lengths of 5 to 25 m. Contacts with adjacent rocks range from sharp and brecciated to gradational and diffuse. Where gradational contacts are found, minor quantities of uranium-bearing minerals occur in association with aggregates of smokey quartz and magnetite, and are peripheral to crystals of hornblende and hematite-bearing albite.

The Imperial Occurrence (5) is unusual in that it appears to have two distinctly different geological settings, both of which exhibit anomalies. The first, and smallest, is associated with a quartz monzonite breccia which carries pyrite and chalcopyrite (*see* deposit type 1 in section "Copper and Molybdenite in Metamorphosed Intrusive Rocks"); the second is associated with carbonate-bearing, volcanically-derived metasediments which are spatially asso-

ciated with a sill of gneissic granite. The majority of the exploration work was carried out on the second occurrence. Here, disseminated grains of uraninite and/or uranothorite(?) are found either adjacent to the sill associated with calcite, magnetite, pyrite, and quartz in recrystallized, banded metasediments; or in quartz-magnetite-pyrite stringers which occur in the sill and in the adjacent rocks.

An additional target for uranium exploration may well be the Precambrian-Paleozoic unconformity which is situated close to most bedrock exposures throughout Harvey Township. Along the unconformity, polymictic conglomerate, and sandy shale directly overlie a hematite-rich zone of intensely weathered Precambrian rocks. The zone varies from 0.5 to 6 cm in width, and is exposed for distances of up to 10 m. The polymictic conglomerate contains pebbles of pegmatitic granite as well as numerous, large crystals of microcline, quartz, and plagioclase. The weathering and erosion of uranium-bearing pegmatites could have led to the formation of uranium minerals within the zone of weathering and sedimentation.

NONMETALLIC DEPOSITS

Sand and Gravel

Small sand and gravel pits are numerous throughout Harvey Township and have been utilized for local road construction. Most of the deposits are relatively shallow and are located in either areas of extensive till, or in stream gravels such as those along the Mississagua River and "old" lakeshore deposits such as those near Pigeon and Buckhorn Lakes.

Marl

Several small concentrations of marl were located in the northwestern corner of Harvey Township in the early 1940s. All of these have a relatively high content of organic material. Only one of these warranted further work, and is described under the property description for "White Valley Chemical Limited" [1940] (6).

Descriptions of Properties

Data on documented mineral occurrences in Harvey Township are presented in Table 5. Properties visited by the author and/or by Satterly (1956) are described below and numbered on the geological map of Harvey Township. Other areas of economic interest are listed in Table 5.

Satterly (1956) visited most of the known uranium occurrences (Properties 1 to 4, see Map 2475) in Harvey Township and compiled mineralogical and as-

TABLE 5 | A LIST OF MINERAL OCCURRENCES IN HARVEY TOWNSHIP.

Property	Name	Lot	Concession	Metals[a]	Year of Work	Work[b] Done	Reference[c]
1	Big Nell Mines Limited	22-26 27	XVI XV	U	1957	4	Sat.
2	Cadesky, L.	26	XVI	U	1956	4	Sat.
3	Cavendish Uranium and Mining Company Limited	17-20 17-20 19	XIV XII XII	U	1954-1955	3,4	Sat.
—	Drude Uranium Mines Limited	1-2 31-2	I VIII	U	1955	1,2	A.F.
—	Glenn Explorations Limited	30 31 32	I II III	U	1967-1968	1,2,3	A.F.
4	Grey Wolf Exploration Company Limited	29-31 29-30	XVI XVII	U	1955-1956-	4	Sat.
—	" " " "	32	XIV	U	1956	4	A.F.
5	Imperial Oil Limited	19-25 20-23	XII XIII	U	1975-1976	1,2,3,4	Pc
—	" " "	20	XII	U	1975	1,2	A.F.
—	Weber-Schriebl	19	I	U	1956	4	A.F.
6	White Valley Chemical Limited	31	XVIII	Marl	1940	5	Lib

Footnotes

a: U = Uranium.

b: 1 = Geological Mapping; 2 = Geophysical Survey; 3 = Trenching; 4 = Diamond Drilling; 5 = Property in Production.

c: Sat. = Satterly (1956); A.F. = Assessment Files Research Office, Ontario Geological Survey, Toronto; Pc = Personal Communication, R. Givens (1978); Lib = Liberty (1969).

say data for each one. Observations on those properties visited by the author (Properties 1 to 3, see Map 2475) generally correspond to those of Satterly (1956).

BIG NELL MINES LIMITED (1).

In 1957 Big Nell Mines Limited optioned lots 22 to 26, concession XVI and the western half of lot 27, concession XV, Harvey Township from R. Kennedy of Bobcaygeon. The company followed up Kennedy's prospecting with a program of trenching and blasting. This work exposed two dikes of pink granite pegmatite which are intrusive into weakly foliated, fresh appearing biotite granite. According to Satterly (1956, p. 175):

> The pegmatite contains abundant coarse magnetite in grains ⅛-1 inch across. Minerals associated with the magnetite are pale-brown anatase(?), bleached zircon, and orange or black uranothorite. The quartz of the pegmatite is glassy clear to faintly smokey.
>
> No.1 dike has been explored by two trenches and five strippings. The dike is from 2 to possibly 15 feet wide, and has an exposed length of 190 feet. It strikes northeast and dips 45°SE. It is characterized throughout its length by abundant coarse hematitized magnetite. Geiger readings obtained over the dike were mainly between 4x and 12x and might average 9x. A spot-high reading of 15x was found on the first stripping, and the trench about 150 feet northeast gave readings of 15x-17x.
>
> No.2 dike is exposed in an outcrop and five strippings. It is 2 to possibly 20 feet wide and has an exposed length of 200 feet. The dike strikes northeast and dips 50°SE, swinging east towards the north end where the dip flattens to 30°S. The distribution of the accessory coarse magnetite is not uniform, and the geiger readings were 3x to a spot high of 60x-90x over a yard-square area at the extreme northeast exposure of the dike. The lowest readings were obtained on those parts of the dike containing little or no magnetite. The average reading for the whole dike may be 6x. Grab samples taken by Mr. Kennedy are reported by him to have given the following assay results: 0.04, 0.08, 0.07, 0.11, and 0.97 percent U_3O_8 (chemical). The latter was obtained on the spot-high area 60x-90x at the northeast end of the No.2 dike. Another analysis on a grab sample from this spot was 0.87 percent U_3O_8 equivalent.

L. CADESKY (2)

In 1956, a program of trenching and stripping was carried out by L. Cadesky on lot 26, concession XVI, Harvey Township. The work exposed a uranium-bearing pegmatite granite dike on the northern side of Nogies Creek some 2 km north of Highway 36.

The dike varies from 1 to 2.5 m in width, is intrusive into a weakly foliated biotite granite, and is composed of: microcline; clear, rose coloured quartz; clots of coarse-grained magnetite with minor amounts of plagioclase, and traces of tourmaline, apatite, pyrite, and biotite. Magnetite varies from 1 to 3 percent in abundance, and forms single crystals or larger irregular masses (1 to 4 cm) which are partly replaced by hematite. Most of the uranium mineralization is associated with aggregates of magnetite.

According to Satterly (1956, p. 174):

> Much magnetite is present in the footwall zone, and the geiger read 15x. A small trench 8 feet north of this point is 20 feet long. The dike is exposed at the west end and has narrowed to 1½ feet.

On the south side of the creek, pegmatite is exposed and gave a reading of 15x and again 80 feet south where it is 7 feet wide. This section read 1.5x with a spot high, rich in magnetite, of 5x. Across the road the dike trends west and is exposed for 35 feet. Here there is some mineral segregation, the centre of the dike, rich in white-rose quartz, read 1-1.5x with a spot-high of 5x on the south contact.

CAVENDISH URANIUM AND MINING COMPANY LIMITED (3).

In 1954 and 1955, Cavendish Uranium and Mining Company Limited held lots 17 to 20, concession XI and lots 17 to 20, concession XII, under option from R. Kennedy of Bobcaygeon. The company carried out a program of trenching, and diamond drilled 13 holes. The author located none of the trenches and found the location of only 4 of the diamond-drill holes.

The diamond drilling outlined a series of uranium-bearing pegmatite dikes and sills, which appear to be intrusive into epiclastic metasediments. Uranium mineralization appears to be restricted to the pegmatites which are composed of microcline, quartz, magnetite, albite, with minor amounts of pyroxene, apatite, and zircon. Assays from diamond-drill core were not available, but geiger readings, according to Satterly (1956, p.176):

> . . .averaged about 40 times background with a spot high of 50 times background.

Also, according to Satterly (1956, p. 176):

> The second surface showing is on a rock exposure on top of the ridge near drill-hole No. K-3. Here a dike of leucogranite pegmatite is exposed at N 80°W for 180 feet from drill-hole K-3. The dike is 9-25 feet wide and strikes N 80°W. It contains scattered accessory magnetite in grains up to ⅛ inch across, minute crystals of zircon, black uranothorite, and rarely pyrite. Geiger readings were variable. Near drillhole K-3 the readings were 10 to 70 times background; elsewhere along the dike they were 3 to 9 times ground, and might average 5 times background or less.

GREY WOLF EXPLORATION COMPANY LIMITED (4).

In 1955 to 1956, Grey Wolf Exploration Company Limited held under option, lots 29, 30, and 31, concession XVI, and the eastern halves of lots 29 and 30, concession XVII, on the eastern side of Nogies Creek some 5.2 km by road north of Highway 36. The company carried out a program of trenching and blasting. This work exposed a sill of granite pegmatite which exhibited anomalous radioactivity. The sill is situated close to the contact between metasediments and a strongly foliated, biotite granodiorite. The sill trends northeast, is exposed for a length of 350 m, and varies from 0.4 to 1.5 m in width.

According to Satterly (1956, p.174-175):

> This zone was examined at intervals over a length of 400 feet and gave geiger readings of 3x-8x and in the two pits up to 12x with a spot-high of 30x where streaks of magnetite are present. Grab samples were taken by the author in two pits, reading 6x and 13x on the samples away from the showing and gave the following results on assay by the Provincial Assay Office: 0.05 percent U_3O_8 (radiometric) and 0.028 percent U_3O_8 (chemical), and 0.13 percent U_3O_8 (radiometric) and 0.076 percent U_3O_8 (chemical). C.P. Cziraky, president, reports that grab samples from No.1 pit (the

northeast pit) contained 0.07 percent gadolinium oxide, 0.4 percent CeO_2, 0.3 percent Nd_2O_3, and 0.3 percent La_2O_3. In these samples U_3O_8 was not detected.

IMPERIAL OCCURRENCE (5)

During 1975 to 76, Imperial Oil Limited carried out a ground radiometric survey and a detailed program of geological mapping, trenching, and diamond drilling over lots 19 to 25, concession XII, and lots 20 to 23, concession XIII, in Harvey Township. The land is owned by R. Givens of Harvey Township.

The property is underlain by a well foliated, elongate north-northeasterly trending stock of quartz monzonite and quartz diorite. The stock is intrusive into metavolcanics and metasediments. Many of the metasediments are carbonate rich. Two zones of anomalous radioactivity were outlined by the various surveys. The first and smallest is associated with a breccia zone near the centre of the intrusion. Here, traces of uranium-bearing minerals are associated with chalcopyrite and pyrite in stringers and veins composed dominantly of quartz, magnetite, and feldspar. The second zone of anomalous radioactivity is associated with carbonate-bearing metasediments which underlie and/or are folded into the intrusion. Uranium occurs in local zones of deformed and recrystallized, layered to massive biotite-quartz schist, calcite-quartz-feldspar schist and gneiss, and biotite-calcite schist. These zones are spatially associated with sills and dikes of granite gneiss and/or veins and stringers of quartz and magnetite. Uranium mineralization appears to be concentrated in carbonate-rich metasediments and/or associated with the late veins.

Four holes were drilled to test the anomaly over the second zone. Although detailed diamond-drill core logs were unavailable, assays indicated only traces of uranium mineralization (R. Givens, personal communication, 1978).

WHITE VALLEY CHEMICAL LIMITED (6)

White Valley Chemical Limited located several small deposits of marl some 10 km north of Bobcaygeon on lot 31, concession XVIII, in Harvey Township. In 1940, the company began production of the largest deposit, but operations appear to have been discontinued the same year. According to Liberty (1969, p. 178):

> Production was used for whiting substitute which may be used as a filler in paper and in the manufacture of explosives, rubber products, etc. The marl at this locality is white and fairly free from clay material, but has a remarkably high content of organic material, i.e. small snail shells.

Genesis of Deposits

Mineral "deposits" and occurrences can be subdivided into 5 distinct types based on rock associations, textures, and mineralogy. The 5 types are:

1. disseminated copper-molybdenum mineralization associated with breccia zones in volcanic intrusive centres
2. exhalative types associated with chemical precipitation, bedded tuffs, and volcanic muds
3. sulphide deposits formed from late hydrothermal and/or circulating meteoric waters with redistribution by metamorphic solutions; this type is associated with felsic and mafic volcanic rocks
4. uranium deposits associated with pegmatite dikes and sills
5. uranium deposits associated with carbonate-bearing metasediments

The extent that metamorphism has played in the localization of mineralization is difficult to assess. Textures are partly metamorphic in origin as is the disposition of sulphide minerals in subconcordant lenses. Metamorphic solution and redeposition may have locally concentrated sulphide minerals during metamorphism; however, most of the observed sulphide minerals are in stratigraphic settings which are similar to those of metal deposits in unmetamorphosed or less intensely metamorphic rocks.

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ONTARIO GEOLOGICAL SURVEY REPORT 230

Geological Map

Map 2475 (coloured)–Harvey Township, Peterborough County.

Scale 1:31 680 or 1 inch to ½ mile.

GALWAY TOWNSHIP

VERULAM TOWNSHIP

To Highway 121

Lavery Creek

Lavery Lake

Little Spinster Lake

Spinster Lake

Voluarno Lake

Nogies Creek

Moraine

Sand or Gravel Pit

XIX XVIII XVII XVI XV XIV XIII XII XI X

VICTORIA COUNTY

PETERBOROUGH COUNTY

Mountain Lake

Mississagua Landing

Collins Island

CAVENDISH TOWNSHIP

Rock Island

Mississagua Lake

Fish House Point

Dairymple Island

Lot 32

Little Spinster Lake

Spinster Lake

Moraine

Fire Tower

Hansa Lake

Cloudy Cr

Cloudy Lake

31

30

29

Tamarack Lake

28

Agate Lake

27

I

II

III

IV

VI

VII

VIII

X

XI

Rockcroft

Sand and Gravel Pit

Moraine

Crane Lake

Crane Creek

26

25

24

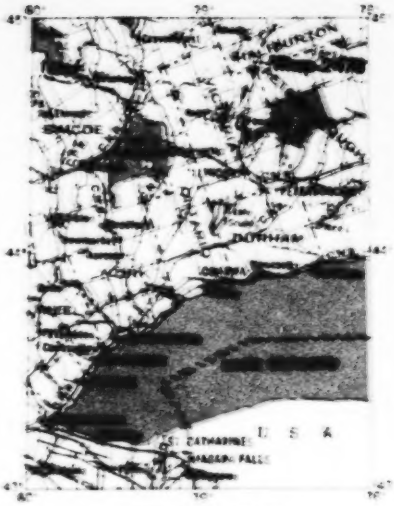
23

22

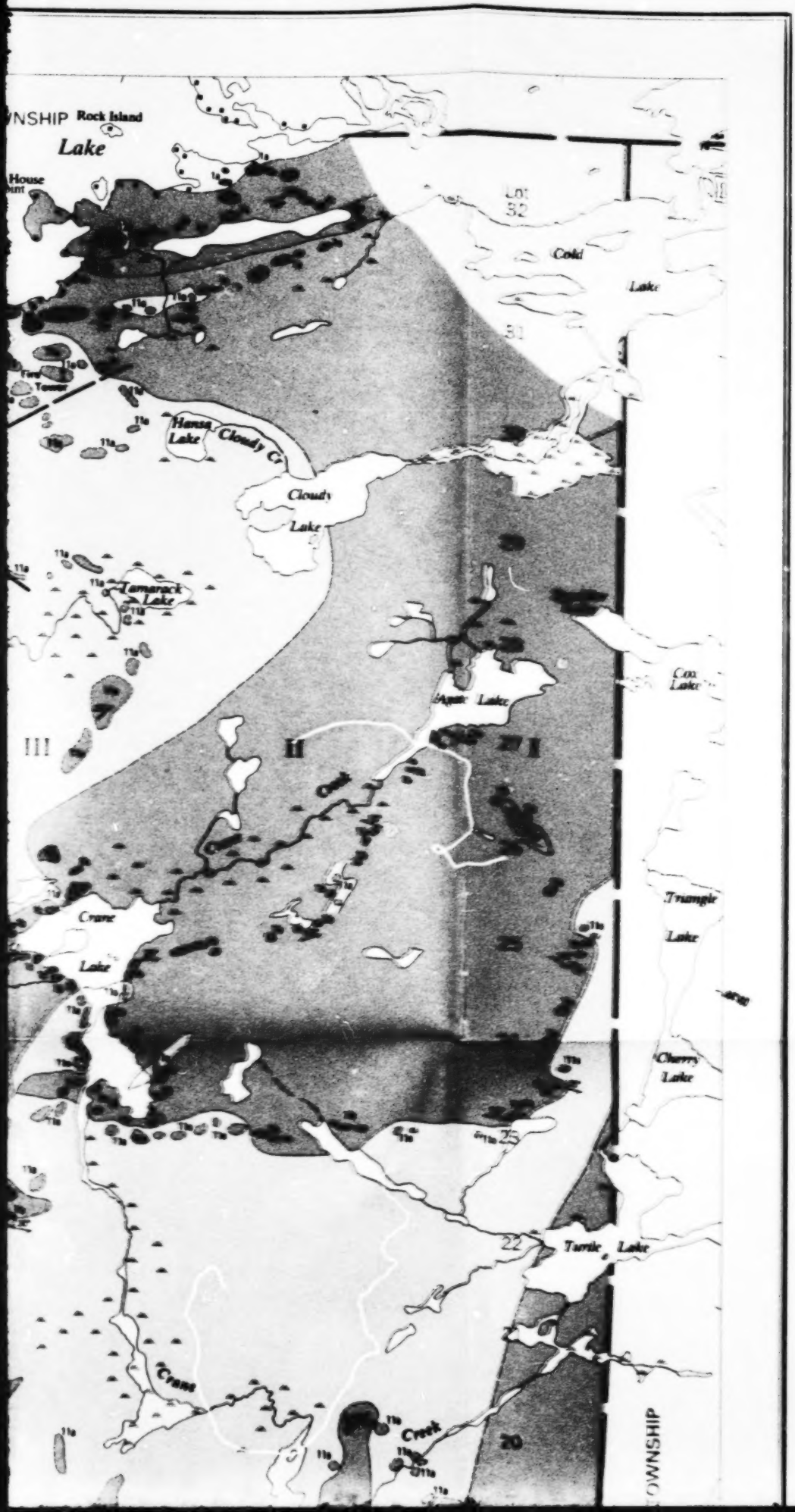
21

20

Harvey Township



Scale 1 inch to 50 miles
N.T.S. reference 31D/7,8,9,10



LEGEND

PHANEROZOIC

CENOZOIC

QUATERNARY

Pleistocene and Recent

Local fluvial and lacustrine deposits, sand, gravel, sands and silty boulder clay, varved clay, swamp accumulations

unconformity

PALEOZOIC

ORDOVICIAN

14a *Lithographic limestone, fossiliferous limestone, limestone breccia, calcareous shale*

14b *Lithic wacke, quartz wacke, polymictic conglomerate, sandy shale*

unconformity

PRECAMBRIAN

LATE PRECAMBRIAN

MAFIC INTRUSIVE ROCKS

13a *Diabase*

intrusive contact

LATE FELSIC INTRUSIVE ROCKS

12a *Pegmatitic granite, granodiorite*

intrusive contact

METAMORPHOSED FELSIC INTRUSIVE ROCKS

11a *Fine to medium grained granite, granodiorite*

11b *Porphyritic biotite granite*

Moraine

COUNTY

VICTORIA COUNTY

PETERBOROUGH

Sand or Gravel Pit

Nogles Creek

Moraine

Moraine

Moraine

Alpine Village

Bruces Island

Tait Bay

Tait Point

Gordon Rocks

Bottom Island

Olivers Point

Fair Oak Point

Rocky Point

PIGEON LAKE

Hurricane Point

Hurricane Reef

Bigelow Bay

Point Pleasant

Nicholas Cove

Nenabush Island

Beacon Island

Green Bay

North Point

Bob Channel

Bobcaygeon River

South River Point

Stumpy Bay

BOBCAYGEON P.O.

Crane Bay

Black Point

Little Bob Channel

Stinsons Bay

Stinsons Point

To Dunsford

Birch Point

Boarding House Reef

Red Rock

North Point

Amburgs Reef

Roetzel Island

Black Channel

Dropping Reef

Lancasters Point

Vivians Shoal

Church Steeple Rock

Snake Island

Bald Lake Narrows

Little Bald Lake

Big Bald Lake

Sandy Lake

HAR

SYMBOLS

- Small bedrock outcrop.
- Area of bedrock outcrop.
- Bedding, top unknown; (inclined, vertical).
- Bedding, top indicated by arrow; (inclined, vertical, overturned).
- Bedding, top (arrow) from grain gradation; (inclined, vertical, overturned).
- Bedding, top (arrow) from cross bedding; (inclined, vertical, overturned).
- Foliation; (horizontal, inclined, vertical).
- Lineation with plunge.
- Geological boundary, observed.
- Geological boundary, position interpreted.
- Fault; (observed, assumed). Spot indicates down throw side, arrows indicate horizontal movement.
- Jointing; (horizontal, inclined, vertical)

SOURCES OF INFORMATION

Geology by R.L. Morton and assistants, Ontario Geological Survey, 1978.

Aeromagnetic map 103G, ODM-GSC.

Ontario Department of Mines: Map 1957b, Haliburton-Bancroft Area, scale 1 inch to 2 miles, 1957.

Sixty-Fifth Annual Review, Satterly, J., 1956.

Geological Survey of Canada memoir 355, Liberty, B.A., 1969

Moraine

Lake

Squaw

HARVEY

Nenabush Island

Nicholas Cove

Bald Lake Narrows

Little Bald Lake

Big Bald Lake

Narrows

Snake Island

Church Steeple Rock

Sandy Lake

Moraine

Moraine

Moraine

LEGEND

PHANEROZOIC

CENOZOIC[a]

QUATERNARY

Pleistocene and Recent

Local fluvial and lacustrine deposits, sand gravel, sandy and silty boulder clay, varved clay, swamp accumulations

UNCONFORMITY

PALEOZOIC

ORDOVICIAN

14a Lithographic limestone, fossiliferous limestone, limestone breccia, calcareous shale
14b Lithic wacke, quartz wacke, polymictic conglomerate, sandy shale

UNCONFORMITY

PRECAMBRIAN[b]

LATE PRECAMBRIAN

MAFIC INTRUSIVE ROCKS

13a Diabase

INTRUSIVE CONTACT

LATE FELSIC INTRUSIVE ROCKS

12a Pegmatitic granite, granodiorite

INTRUSIVE CONTACT

METAMORPHOSED FELSIC INTRUSIVE ROCKS

11a Fine to medium grained granite, granodiorite
11b Peristerite-bearing granite, granodiorite
11c Aplitic granite, minor alaskite

INTRUSIVE CONTACT

METAMORPHOSED INTERMEDIATE INTRUSIVE ROCKS

10a Biotite granodiorite, quartz diorite
10b Hornblende granodiorite, quartz diorite

INTRUSIVE CONTACT

METAMORPHOSED INTERMEDIATE TO MAFIC INTRUSIVE ROCKS

9a Quartz monzonite, quartz diorite, minor monzonite
9b Gneissic gabbro, hornblendite, hornblende schist, metaperidotite

METAVOLCANICS AND METASEDIMENTS

UPPER METASEDIMENTS[a]

CLASTIC METASEDIMENTS

8a Biotite schist, muscovite schist, quartz-plagioclase-biotite schist and gneiss, minor wacke, siltstone, and conglomerate
8b Sillimanite-bearing schist[d]

CHEMICAL METASEDIMENTS

7a Muscovite-quartz-pyrite schist, quartz-rich metatuff, chert, calcite-quartz schist, feldspar biotite schist, quartz-biotite schist and gneiss, minor marble, iron formation, amphibolite, and metarhyolite

METAVOLCANICS[a]

MAFIC TO FELSIC FRAGMENTAL ROCKS

6a Lapilli tuff, bedded tuff, fragment-rich ash flow tuff
6b Debris flow deposits, minor bedded sediments

FELSIC METAVOLCANICS

5a Flows, flow breccia, fragment-poor ash flow tuff
5b Dykes, sills, small intrusions
5c Potassium feldspar-biotite schist and gneiss[d]

MAFIC METAVOLCANICS

4a Porphyritic flows
4b Massive flows, amygdaloidal flows, autoclastic and flow

PIGEON LAKE

Hurricane Point
Hurricane Reef
Point Pleasant
Bigelow Bay
Nicholas Cove
Nenabush Island
Bald Lake Narrows
Little Bald Lake
Big Bald Lake
Narrows
Vivians Shoal
Church Steeple Rock
Snake Island
Lancasters Point
Dropping Reef
Birch Point
Boarding House Reef
North Point
Red Rock
Amburgs Reef
Roetzel Island
Black Channel
Sandy Lake
Moreibe
Brown Point
Buckhorn
Greenwood
Rocky Point
Sand or Gravel Pit
Green Bay
North Point
Beacon Island
Big Bob Channel
(Bobcaygeon River)
South River Point
Stumpy Bay
BOBCAYGEON P.O.
Crane Bay
Black Point
Little Bob Channel
(Bobcaygeon River)
Stinsons Bay
Stinsons Point
To Dunsford
Sand or Gravel Pit
Falls Point
Long Point Reef
Long Point Bay

SYMBOLS

- Small bedrock outcrop.
- Area of bedrock outcrop.
- Bedding, top unknown; (inclined, vertical)
- Bedding, top indicated by arrow; (inclined, vertical, overturned).
- Bedding, top (arrow) from grain gradation; (inclined, vertical, overturned).
- Bedding, top (arrow) from cross bedding; (inclined, vertical, overturned).
- Foliation; (horizontal, inclined, vertical).
- Lineation with plunge.
- Geological boundary, observed.
- Geological boundary, position interpreted.
- Fault; (observed, assumed). Spot indicates down throw side, arrows indicate horizontal movement.
- Jointing; (horizontal, inclined, vertical)
- Drag folds with plunge.
- Anticline, syncline, with plunge.
- Drill hole; (vertical, inclined)
- MA — Magnetic attraction.
- Bedding, top (arrow) from flow contacts, fragment types, and sorting of fragments.
- 28 — Motor road. Provincial highway number encircled where applicable.
- Other road.
- Trail, portage, winter road.
- Building.
- Swamp, inundated land.
- County boundary, approximate position only.
- Township boundary, meridian or base line, approximate position only.
- 3 — Mineral deposit; mining property, unsurveyed, approximate position only.
- Location of analysed sample.

SOURCES OF INFORMATION

Geology by R.L. Morton and assistants, Ontario Geological Survey, 1978.

Aeromagnetic map 103G, ODM-GSC.

Ontario Department of Mines:
Map 1957b, Haliburton-Bancroft Area, scale 1 inch to 2 miles, 1957.

Sixty-Fifth Annual Review, Satterly, J., 1956.

Geological Survey of Canada memoir 355, Liberty, B.A., 1969.

Preliminary maps, Ontario Geological Survey; P2343, Harvey Township (east half); P2344, Harvey Township (west half), scale 1 inch to ¼ mile, 1: 15840, 1978.

Cartography by M.G. Sefton, assisted by B.G. McQuaid, Survey's and Mapping Branch, 1981.

Base map derived from maps of the Forest Resources Inventory, Surveys and Mapping Branch.

Magnetic declination in the area was approximately 10° West, 1978.

Parts of this publication may be quoted if credit is given. It is recommended that reference to this map be made in the following form:

Morton, R.L.
1982: Harvey Township, Ontario Geological Survey Map 2475, Precambrian Geology Series scale 1 inch to ½ mile, 1: 31680, Geology 1978.

PROPERTIES, MINERAL DEPOSITS

1. Big Nell Mines Ltd. [1957]
2. Cadesky, L. [1957]
3. Cavendish Uranium and Mining Co. [1955]
4. Grey Wolf Exploration Co. [1956]
5. Imperial occurrence.
6. White Valley Chemical Ltd. [1940]

Information current to December 31st 1978. Former properties on ground now open for staking are only indicated if exploration data is available – a date in square brackets indicates last year of exploration activity. For further information see report.

Ministry of Natural Resources
Ontario

Ontario Geological Survey

Map 2475

HARVEY TOWNSHIP

PETERBOROUGH COUNTY

Scale 1:31,680 or 1 Inch to ½ Mile

Chains 80 60 40 20 0 1 2 Miles
Metres 1000 0 1 2 3 Kilometres
Feet 1000 0 5,000 10,000 Feet

Published 1982

Big Bald Narrows
Big Bald Lake
Mississagua
Moraine
Moraine
Moraine
Buckhorn P.O.
Buckhorn Lock 31
Johnsons Point
Red Rock Island
Tooke Rock
Freeborn Point
Deer
Longpine Point
Longpine Point Island
Three Sister Island
Traynor Point
Lower Buckhorn Lake
Bay
Reach
Hall Point
Nicholls Point
Wood Wharf Point
Buckhorn
Brown Point
Lake
Buckhorn Narrows
Greenwood Island
507
Victoria Springs
Craft Point
Black Point
Tanner Point
Three Islands
Black Duck Bay
South Blackduck Dam
Grassy Island
Dinnertime Island
Heron Island
Gull Rock
Worrell Island
Jacknife Island
Rose Island
Dynamite Island
Lovesick Lake
Richards Island
Marshall Island
Beaver Island
Taylors Island
Feathers Island
Howell Island
McCallum Island
Lovesick Lock 30
McBean I.
Rebus I.
Watcher I.
Spook Island
Millage Point
Millage I.
Davis Point
Greyduck Dam
Sunset Dam
Meyers Island
Deer
Bay
16
15
14
13
12
11
10
9
8
7
Lot 9
2 Miles
3 Kilometres
0,000 Feet
To Selwyn
SMITH TOWNSHIP
To Youngs

METAVOLCANICS AND METASEDIMENTS

UPPER METASEDIMENTS[c]

CLASTIC METASEDIMENTS

- 8a *Biotite schist, muscovite schist, quartz-plagioclase-biotite schist and gneiss, minor wacke, siltstone, and conglomerate*
- 8b *Sillimanite-bearing schist*[d]

CHEMICAL METASEDIMENTS

- 7a *Muscovite-quartz-pyrite schist, quartz-rich metatuff, chert, calcite-quartz schist, feldspar biotite schist, quartz-biotite schist and gneiss, minor marble, iron formation, amphibolite, and metarhyolite*

METAVOLCANICS[c]

MAFIC TO FELSIC FRAGMENTAL ROCKS

- 6a *Lapilli tuff, bedded tuff, fragment-rich ash flow tuff*
- 6b *Debris flow deposits, minor bedded sediments*

FELSIC METAVOLCANICS

- 5a *Flows, flow breccia, fragment-poor ash flow tuff*
- 5b *Dykes, sills, small intrusions*
- 5c *Potassium feldspar-biotite schist and gneiss*[e]

MAFIC METAVOLCANICS

- 4a *Porphyritic flows*
- 4b *Massive flows, amygdaloidal flows, autoclastic and flow breccia*
- 4c *Amphibolite, banded amphibolite, bedded hornblende schist, hornblende-biotite-garnet schist*
- 4d *Mafic dykes and sills*

LOWER METASEDIMENTS[c]

CHEMICAL METASEDIMENTS

- 3a *Calcitic marble, tremolite-actinolite bearing marble*
- 3b *Dolomitic marble*

CLASTIC METASEDIMENTS

- 2a *Sandstone, pebble conglomerate, siltstone, biotite rich to biotite poor quartz-feldspar-gneiss, minor quartz schist*

BURLEIGH GNEISS COMPLEX[f]

- 1a *Banded quartz-feldspar-biotite gneiss*[g]
- 1b *Feldspar-quartz-biotite-layered and nebulitic-migmatite*[g] *migmatitic granodiorite and quartz diorite.*

Breccia

asp	*Arsenopyrite.*	**mo**	*Molybdenite.*
bn	*Bornite.*	**py**	*Pyrite.*
cp	*Chalcopyrite.*	**po**	*Pyrrhotite.*
ma	*Marl.*	**sp**	*Sphalerite.*
mag	*Magnetite.*	**U**	*Uranium.*

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[a] *Unconsolidated deposits. Cenozoic deposits are represented by the lighter coloured and uncoloured parts of the map.*

[b] *Bedrock geology. Outcrops and inferred extensions of each rock map unit are shown respectively in deep and light tones of the same colour.*

[c] *The rocks of these groups are subdivided lithologically and the order does not imply age relationships.*

[d] *Volcanic mudstone.*

[e] *Associated with felsic breccias and flows.*

[f] *Multiple ages are probably represented, i.e. both rocks of Pre-Grenville and Grenville Supergroup.*

[g] *Includes up to 50% sills and dykes of units 11 and 12.*

POOR

QUALITY

ORIGINAL